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A PLOT TEST OF FIVE THAILAND RICE VARIETIES AND SERAUP KECHIL 36 STRAIN 482 UNDER LOWLAND CONDITIONS [1]

VALERIANO C. CALMA AND CORNELIO G. BELOSO

Seraup Kechil 36 strain 482 significantly outyielded Nang Tani, which yielded more than the other Thailand varieties—Bang Phra, Kao-Phu-Dard, Namdokmai, and Pin Keo.

Several Thailand rice varieties have been introduced and studied in this College. Bayubay [2] found that of the 10 leading Thailand rice varieties he studied, five—Bang Phra, Kao-Phu-Dard, Namdokmai, Nang Tani, and Pin Keo—were fairly high yielders.

In the present work these five Thailand rice varieties were plot tested, using Seraup Kechil 36 strain 482 as the control, (a) to study their agronomic characteristics, such as number of bearing culms; tillering, booting, flowering, and maturity periods; lodging and non-lodging habits; susceptibility to pests and diseases; shattering quality; and milling percentage when grown under lowland conditions; and (b) to determine their comparative yields. This work was conducted from July, 1953, to September, 1954.

MATERIALS AND METHODS

A 2,500-square-meter portion of the lowland rice field of the Central Experiment Station was divided into five replicated blocks of six plots each. The five Thailand rice varieties and the control were assigned at random to the plots in each block.

The seedbed was prepared by the ordinary wet-bed method. To facilitate the decomposition of weeds and trash, the area was irri-

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[1] Central Experiment Station Contribution No. 1851. Based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agronomy under the direction of the senior author.

[2] E. P. Bayubay, "The Performance and Other Agronomic Characteristics of Ten Thailand Varieties of Rice When Grown under Local Lowland Conditions." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1954. Unpublished.)

gated after plowing. The land was harrowed three times, leveled once, and divided into six plots of 15 square meters each.

The percentage of germination of the different varieties was determined in the laboratory by the rag-doll method. On July 31, 1953, one ganta of seeds of each variety was soaked in water for 48 hours and incubated in the shade for the same period of time to hasten germination. On August 4, 1953, the partially germinated seeds were sown in the seedbeds at the rate of 25 gantas to the hectare.

Two weeks after sowing, the germination of the seeds and the appearance of seedlings were noted. The seedlings were observed for any sign of damage caused by pests and diseases.

The field was plowed once and harrowed thrice. Just before the transplanting of the seedlings, it was thoroughly puddled and leveled.

Ten seedlings taken at random from each variety were measured for height 30 days after sowing. The seedbed was irrigated a day before to facilitate the pulling of the seedlings and to wash off the soil particles adhering to the roots. Only the healthy and vigorous seedlings of each variety were chosen for transplanting. About one-third of their height was pruned to minimize transpiration.

The ordinary lowland method of transplanting rice was used. Two to three 30-day-old seedlings were planted to a hill. The hills were set 25 centimeters apart. A week after transplanting, the paddies were irrigated to submerge the weeds and to hasten the growth of the rice plants. Nine days later, the missing hills were replanted.

The water in the paddies was kept at the right level to control the weeds and to hasten the growth of the plants. The dikes and the spaces between plots were kept clean to keep away rats and other pests. All necessary measures were taken to control pests and diseases.

The appearance of the plants was observed twice a week from transplanting to maturity. Observations were also made on the tillering, booting, flowering, and maturity periods and the lodging characteristics of the different varieties. The number of bearing culms was determined from 10 hills taken at random from each plot in all the replications.

Harvesting was done as soon as the majority of the plants had matured in each plot. The plants were cut 50 centimeters above the ground, threshed, and placed in properly labeled sacks. The

grains were dried and then weighed before and after winnowing to find the weight of the filled and empty grains.

Five gantas of clean palay of each variety were milled to determine the milling percentage.

RESULTS AND DISCUSSION

Germination in laboratory and seedbed. In the laboratory test, Bang Phra, Namdokmai, Nang Tani, and Pin Keo had 96 per cent germination; Kao-Phu-Dard and the control had 98 per cent. The different varieties germinated two days after they were sown. The early germination may be attributed to the treatments given.

The Thailand rice varieties were dark green two weeks after they were sown. Seraup Kechil 36 strain 482 was pale green. In general, the seedlings of each variety were vigorous and uniform in height; however, at the time of transplanting or 30 days after sowing, slight differences in height were noted. The average heights in centimeters of the seedlings were as follows: Pin Keo, 55.7; Namdokmai, 53.7; Bang Phra, 50.7; Kao-Phu-Dard, 49.9; Nang Tani, 49.7; and the control, 44.7.

Appearance of transplanted seedlings. The first week after transplanting, the leaves of the plants were pale green. At the beginning of the second week the five Thailand rice varieties and the control gradually became darker in color. Pin Keo was the darkest, the rest of the Thailand rice varieties were medium green, and Seraup Kechil 36 strain 482 was the lightest. As a whole, the plants of the different varieties were vigorous and uniform in height in all the plots.

Number of bearing culms. The number of bearing culms of Nang Tani ranged from 12.1 to 14.8 with an average of 13.4. On the other hand, Seraup Kechil 36 strain 482 had an average of 16.3, the number of bearing culms ranging from 12.6 to 20.7.

The plant crops of Bang Phra, Kao-Phu-Dard, Namdokmai, and Pin Keo were destroyed in the early dough stage by a species of bat called *bayakan;* hence, their number of bearing culms was not noted. However, they produced ratoon crops which ultimately reached maturity. Bang Phra had an average number of 8.0 bearing culms; Namdokmai, 6.9; Kao-phu-Dard, 6.7; Pin Keo, 6.5; and Nang Tani, 5.5.

Tillering period. Three weeks after transplanting, the Thailand rice varieties and the control started to produce tillers. Nang

Tani and Seraup Kechil 36 strain 482 stopped producing tillers after flowering. The rest of the Thailand rice varieties completed tillering 119 to 123 days after sowing.

Booting period. Among the Thailand rice varieties, Nang Tani booted last, within 123 days after sowing. Bang Phra, Kao-Phu-Dard, and Pin Keo booted in 109 days; Namdokmai, in 114 days. Seraup Kechil 36 strain 482 booted within 131 days after sowing, which was markedly the latest among the varieties studied.

Flowering period. Three of the five introduced varieties, Bang Phra, Kao-Phu-Dard, and Pin Keo, flowered within 119 days after sowing. The control took the longest to flower, 138 days. Namdokmai flowered within 123 days after sowing; Nang Tani, within 131 days, which was the longest period among the Thailand rice varieties.

One of the characteristics observed in the Thailand rice varieties was their ability to ratoon. The days from sowing to flowering of the ratoon crops were as follows: Bang Phra, 163 days; Kao-Phu-Dard, 163 days; Namdokmai, 165 days; Pin Keo, 163 days; and Nang Tani, 178 days. Seraup Kechil 36 strain 482, the last variety to mature, did not produce any ratoon crop.

Maturity period. The plant crops of Bang Phra, Kao-Phu-Dard, Namdokmai, and Pin Keo flowered early but were destroyed before maturity. Nang Tani matured in 170 days, and Seraup Kechil 36 strain 482, in 175 days.

The ratoon crops of Bang Phra and Kao-Phu-Dard matured in 184 days; Namdokmai and Pin Keo, in 186 days; and Nang Tani, in 197 days.

Degree of lodging. Slight lodging was observed in varieties Pin Keo, Nang Tani, and Seraup Kechil 36 strain 482 during their milk stage. Lodging was not observed in the ratoon crops of the four Thailand varieties. The plant crops of Nang Tani and Seraup Kechil 36 strain 482 lodged close to the ground as they approached maturity, probably because of the weight of the panicles.

Susceptibility to pests and diseases. Some plants of Bang Phra, Kao-Phu-Dard, Namdokmai, and Pin Keo were damaged by rats during the booting stage. These pests were easily controlled by irrigating the paddies to full capacity. All of the Thailand rice varieties were attacked by the rice bug (*Leptocorisa acuta* Thunberg) during the flowering and milk stages. The four varieties were the only ones flowering in the locality at that time so that the attack of the rice pest was centered on them. When the plants were at the early dough

stage, they were entirely damaged by *bayakan.* Similar attacks were reported by Calma and Paguio.[3] The attacked plants remained erect and, except for the lost panicles, appeared uninjured.

Nang Tani was also attacked by red rice weavers (*Lonchura ferruginosa jagori* Martens) at maturity, but the damage was slight because the field was closely guarded. Seraup Kechil 36 strain 482 was not attacked by *bayakan.* It was also the least attacked by rice bug and red rice weavers because it flowered and matured at the same time as the majority of the rice crops in the locality.

Shattering quality. The plant crops of the two varieties which reached maturity shattered easily. A slight trampling shattered them immediately.

The ratoon crops of the other Thailand varieties also shattered very readily. They were easily threshed, and a slight shaking of the dried panicles during harvesting made the grains fall off.

Yield. The average yield of Nang Tani was 7.3 kilograms (table 1). Seraup Kechil 36 strain 482 gave a mean yield of 20.6 kilograms, significantly outyielding Nang Tani.

TABLE 1.—*Yield in kilograms of cleaned palay of the plant crops of Nang Tani and Seraup Kechil 36 strain 482*

VARIETY	BLOCK					VARIETY TOTAL	VARIETY MEAN
	1	2	3	4	5		
Nang Tani	3.4	3.6	4.8	15.1	9.5	36.4	7.3
Seraup Kechil 36 strain 482	14.1	18.1	21.3	25.3	24.1	102.9	20.6
Total	17.5	21.7	26.1	40.4	33.6	139.3	

Analysis of variance

SV	DF	SS	VARIANCE	COMPUTED F-VALUE
Block	4	169.28	42.32	11.38
Variety	1	442.22	442.22	118.88 [a]
Block × Variety	4	14.88	3.72	
Total	9	626.38		

[a] Highly significant.
SMD at 5% (V) = 3.39.
SMD at 1% (V) = 5.62.

[3] V. C. Calma and M. D. Paguio, Philippine Agriculturist 31, 298 (1948).

The ratoon crop of Pin Keo gave a mean yield of 5.2 kilograms, and that of Nang Tani, 3.1 kilograms (table 2). The three other varieties produced more or less the same amount of filled grains. There was no significant difference in the yields of the ratoon crops of the four Thailand rice varieties. However, the value of F is suggestive.

TABLE 2.—*Yield in kilograms of cleaned palay of the ratoon crops of the five Thailand rice varieties*

VARIETY	BLOCK					VARIETY TOTAL	VARIETY MEAN
	1	2	3	4	5		
Bang Phra	3.9	3.0	6.0	5.0	4.7	22.6	4.5
Kao-Phu-Dard	5.5	4.1	5.3	3.9	3.8	22.6	4.5
Namdokmai	4.2	3.6	5.1	5.2	5.3	23.4	4.7
Nang Tani	3.8	4.2	3.8	1.6	2.0	15.4	3.1
Pin Keo	3.7	3.4	5.5	6.2	7.2	26.0	5.2
Total	21.1	18.3	25.7	21.9	23.0	110.0	

Analysis of variance

SV	DF	SS	VARIANCE	COMPUTED F-VALUE
Block	4	5.84	1.46	1.14
Variety	4	12.45	3.11	2.43 [a]
Block × Variety	16	20.41	1.28	
Total	24	38.70		

[a] Suggestive.

The combined yield of the plant and ratoon crops of Nang Tani was only a little more than half the yield of the control.

Average percentages of filled and empty grains. In the plant crops of Nang Tani and Seraup Kechil 36 strain 482 the percentages of filled and empty grains varied greatly. Nang Tani, which matured one week ahead of Seraup Kechil 36 strain 482, gave an average of 84.6 per cent filled grains and 15.4 per cent empty grains. Seraup Kechil 36 strain 482 gave an average of 91.6 per cent filled grains and 8.4 per cent empty grains. This great difference may be attributed to the fact that Nang Tani was attacked by rice bugs, which sucked the contents of the grains during the milk stage. Seraup

Kechil 36 strain 482, which matured at the same time as the rice crops in the nearby fields, was only slightly attacked by rice bugs.

There was little variability in the amounts of filled and empty grains of the ratoon crops of the four other Thailand rice varieties. The percentage of filled grains varied from 78.2 to 86.8, and the percentage of empty grains, from 13.1 to 21.8.

Computed yield to a hectare based on yield. The computed yields to a hectare based on the total yields of the different varieties showed that Nang Tani produced 39.2 cavans, the highest among the Thailand rice varieties; Pin Keo, 19.7 cavans; Namdokmai, 17.7 cavans; Bang Phra, 17.1 cavans; and Kao-Phu-Dard, 17.1 cavans. The computed yield to a hectare of Seraup Kechil 36 strain 482 was 77.9 cavans.

Milling percentage. The milling percentages of the different Thailand rice varieties and the control are as follows: Pin Keo, 65.4, the highest among the Thailand rice varieties; Bang Phra, 61.1; Namdokmai, 60.0; Kao-Phu-Dard, 59.9; and Nang Tani, 56.0. Seraup Kechil 36 strain 482 had a milling percentage of 65.6, the highest among the varieties studied.

FLORAL BIOLOGY AND CYTOLOGY OF MANIHOT UTILISSIMA [1]

JOSÉ M. CAPINPIN AND VICENTE C. BRUCE

The protogynous inflorescence of cassava contains both male and female flowers. The opening of the flowers is concentrated between 12 m. and 1:00 p.m. The haploid number of chromosomes is 18 in the pollen mother cells of varieties Gariasa, Vassourinha, Aipin Manteiga, Copeland, Berat, and Kekabu. In the metaphase plants of somatic divisions in root tips, 36 chromosomes were found. Cuttings and seedlings of Manihot clones planted at the same time flowered simultaneously.

Cassava is one of the most important root crops which are fast gaining prominence in agricultural and industrial enterprises. An understanding of its basic botanical features would serve as a background for the genetic improvement of the plant.

The present investigation was conducted from December, 1953, to January, 1955, to study the floral biology, cytology, and fruiting habits of cassava under Philippine conditions.

MATERIALS

The six varieties of cassava that were included in this work were Gariasa, Vassourinha, Aipin Manteiga, Copeland, Berat, and Kekabu.[2]

PROCEDURE

Observation of floral characteristics. The position of the developing staminate and pistillate buds at the earliest sign of flowering was observed.

Flowers in the different stages of development were collected at intervals from January, 1954, to March, 1954, and from October, 1954, to January, 1955, for macroscopic and microscopic examinations.

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[1] Central Experiment Station Contribution No. 1852. Based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agricultural Botany under the direction of the senior author.

[2] Some of the materials were furnished by the Economic Garden, Bureau of Plant Industry, Los Baños, Laguna.

Thirty flower buds of each of the four varieties were observed for 24 hours to determine the period of anthesis. The flowering period of some of the plants was recorded, starting from the day the stem cuttings were planted to the time the first sign of flowering was noted.

Ten male flower buds were observed within a 24-hour period to determine the time of dehiscence. At night the initial time of shedding of the pollen was observed. The anthers were examined every two hours by gently spreading apart the calyx lobes with a pair of forceps.

Cytological techniques: smear method. The procedure adopted for counting the number of chromosomes for the root tips was the smear method. The root systems were chilled by placing the pots containing the growing plants on ice overnight at room temperature. Root tips were excised and fixed in 1.3 acetic alcohol for ½ to 3 hours. They were cleaned thoroughly by rolling them on a piece of cloth moistened with fixing or mordanting solution. The root tips were mordanted from 3 hours to overnight in a fresh mixture of 2.5 parts of 3 per cent ferric ammonium sulfate stock solution and 7 parts of 95 per cent alcohol. They were then placed on a glass slide with a few drops of 70 per cent alcohol, and the brownish-yellow meristem regions were cut out. They were transferred to a covered dish containing a few drops of aceto-carmine, stained for 10 to 15 minutes, and stirred occasionally. The root tips were again transferred to a glass slide with a few drops of aceto-carmine diluted with three parts of 45 per cent acetic acid. The slide was covered with a cover slip and heated over a small flame until the tissue was completely soft. The tissue was spread to the thickness of one cell first by sharply tapping individual root tips with the wooden end of a dissecting needle, then placing a piece of filter paper on the cover slip and pressing it with the thumb. The preparation was made permanent by floating off the cover slip in 1:3 acetic alcohol and sealing with balsam.

The schedule for meiotic studies in flower buds was slightly varied at fixing and at mordanting.

Most of the work on chromosome counts was done by smearing the anthers with either aceto-carmine or aceto-orcein. Chromosome counts were made from the root tips and smears of the pollen mother cells.

Parrafin method. Somatic chromosome counts were determined from root tip preparations according to the approved paraffin method.

Techniques of cross-pollinating cassava varieties. The inflorescences on the male and female parents were bagged either after 5:00 p.m. previous to crossing or before 8:00 a.m. on the day the crossing was performed. Only the flowers that were due to open on the day of crossing were retained. The female flowers were pollinated as they opened by dusting the stigmas with the pollen-laden anthers of collected male flowers. Pollinated females were paper-bagged and labeled. The paper bags were removed after 96 hours.

Seed observations. The general external morphological characteristics of the seeds were noted.

On January 21, 1954, during the first planting, 340 seeds were sown. These seeds did not receive any treatment except occasional watering until the seedlings were ready for transplanting.

DISCUSSION OF RESULTS

Flowering habits of cassava. The cassava plant is monoecious with respect to sex, for it bears both the staminate and pistillate flowers on the same cluster (figs. 1 and 2). The numerous male flowers are terminal, and the few female flowers appear at the basal portion of the same inflorescence. The ratio of male to female flowers vary among varieties, but in general there is a preponderance of male flowers (table 1). The male flowers are somewhat campanulate and are five-lobed, and the calyxes are usually colored. There are ten stamens inserted in two rows between the lobes of the disk. The filaments are free. The pistil is large, the ovary is three-celled, and the cells are one-ovuled. One unknown variety of this plant was a variant with all staminate flowers and an abnormal female flower with staminodes (fig. 1h).

Anthesis. Anthesis in cassava is subject to weather and climatic influences and may vary in different places. Preliminary observations showed that the female flower buds, about 9 to 10 mm. long, and the male flower buds, 8 to 9 mm. long, opened the next day. On January 27, 1954, thirty flower buds, about 9 to 10 mm. long, and the male flower buds, 8 to 9 mm. long, opened the next day.

On January 27, 1954, thirty flower buds of each of the four varieties under study were observed for 24 hours to find the duration of anthesis. The male flowers had a lower percentage of opening

TABLE 1.—*Distribution of male and female flowers on each cassava plant*

PLANT NO.	VASSOURINHA		GARIASA		COPELAND		BERAT		KEKABU		AIPIN MANTEIGA	
	M	F	M	F	M	F	M	F	M	F	M	F
1	10	1	30	40	17	8	18	9	6	4	90	12
2	16	4	10	30	14	10	25	16	4	6	70	8
3	8	3	25	35	19	16	28	18	3	4	98	16
4	18	6	8	12	16	12	10	6	12	8	94	14
5	12	5	6	4	6	4	34	28	7	8	64	8
Total	64	19	81	125	72	50	115	77	32	30	416	58
%	77	23	61	39	59	41	60	40	52	48	88	12
Mean	16.6		41.2		24.4		38.4		12.4		94.8	

than the female flowers. The opening took place within a relatively short period. Twenty-seven, or 90 per cent, of the male flowers of the Berat variety opened between 12:00 m. and 12:30 p.m.; 29, or 97 per cent, of the female flowers of the Gariasa variety, between 12:00 m. and 12:30 p.m.; 29, or 97 per cent, of the female flowers of the Copeland variety, between 12:30 and 1:00 p.m.; and 28, or 93 per cent, of the male flowers of Aipin Manteiga, between 12:00 m. and 12:30 p.m.

No female or male flower was observed to open before 11:00 a.m. and after 1:30 p.m. There is little doubt that the high temperature influenced the opening of the flowers. The seven flowers that did not open on the day of the observation opened the next day between 12:00 m. and 12:30 p.m. The sepals began closing at 2:00 p.m., and by 4:00 p.m. some of the flowers were closed.

Dehiscence. In the experiment conducted on January 29, 1954, all anthers of the 10 flowers studied dehisced their pollen from about 9:30 to 11:00 a.m. the next day. This finding was consistent with that of Chandraratna and Nanayakkara that dehiscence commences 2 to 2½ hours before the opening of the flowers and is completed only during the hour preceding opening.[3] The pollen was rapidly blown by the wind after the flowers opened, and the anthers were almost completely empty by 5:00 p.m.

Insect visitors. Several insect visitors were noted throughout the flowering period of the cassava plants.

[3] M. F. Chandraratna and K. D. Nanayakkara, *Trop. Agric.* (*Ceylon*), 101 [4], 214 (1948).

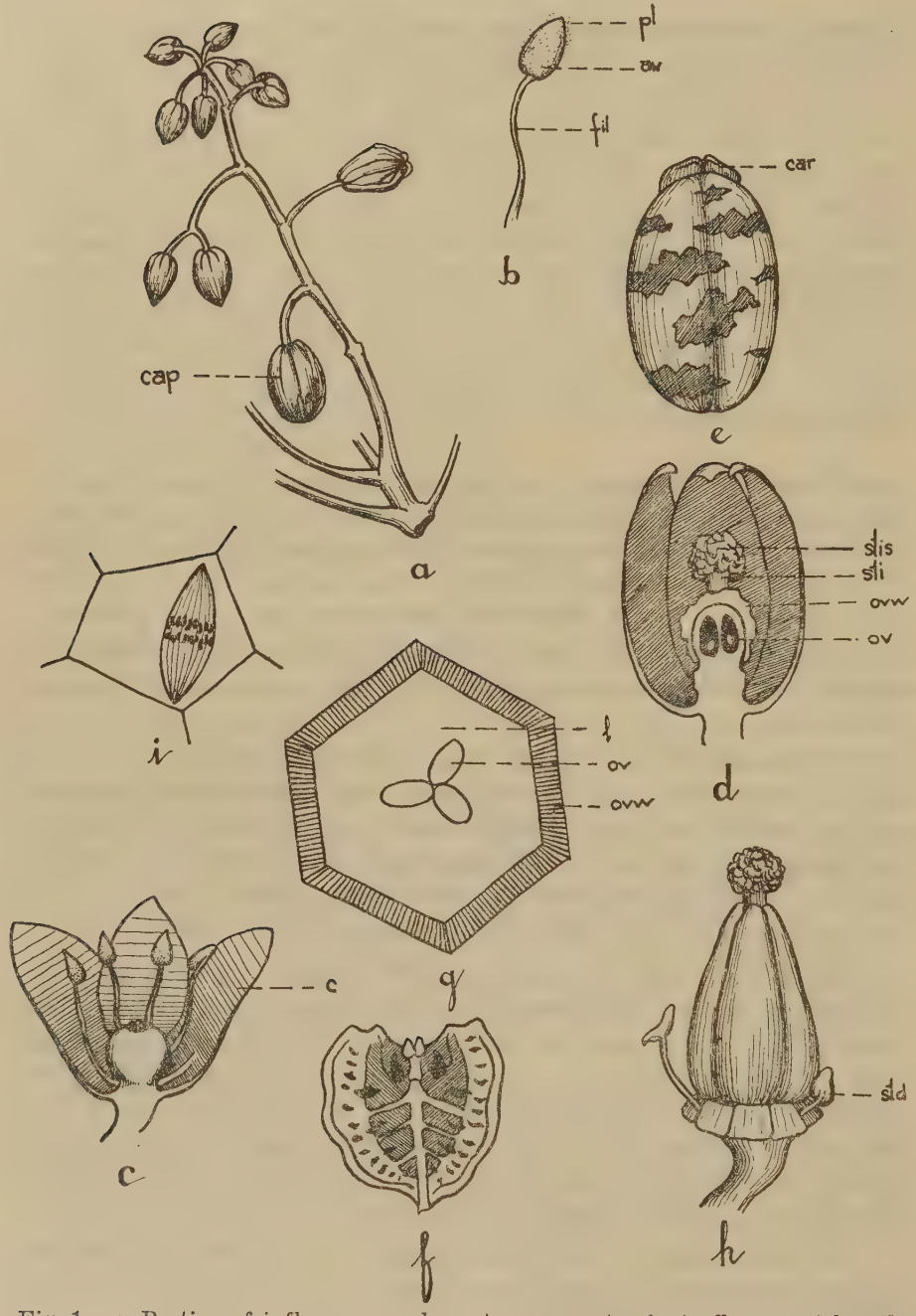

Fig. 1.—a. Portion of inflorescence; b. a stamen; c. staminate flower cut lengthwise; d. pistillate flower cut lengthwise; e. seed; f. one carpel of the ripe fruit showing the seed; g. transverse section of the ovary; h. an abnormal female flower with staminodes; i. enlarged somatic tissue with its nucleus at late metaphase stage.

Parts of the flower, fruit, and seed are designated as follows: (an) anther, (fil) filament, (c) calyx, (pl) pollen, (cap) capsule, (ov) ovule, (sti) stigma, (stis) stigmatic surface, (ovw) ovary wall, (std) staminode, (l) locule, and (car) caruncle.

On January 31, 1954, some insects were seen to visit the flowers from 12:00 m. to 2:00 p.m. when all of the flowers were open. The honey bees sucked the nectar and then flew away. The housefly made rare visits. Ants were often found crawling on the plants. These insects visited one flower after another, making cross-pollination possible. They often punctured both the pistillate and staminate buds. These visitors may be considered possible agents in pollination. Mendiola stated that cassava is insect-pollinated and that its most frequent visitor is the honeybee.[4]

Fertility tests. To determine definitely whether Gariasa, Berat, Copeland, and Aipin Manteiga are cross-fertile, 33 pollinations were made on February 8, 1954. The results of such crosses follow:

When Gariasa and Aipin Manteiga were crossed the percentage of successful pollinations was high, 66. Aipin Manteiga can be considered a good source of pollen.

When Gariasa and Berat were crossed, the percentage of success was only 16, but there is no reason to assume incompatibility.

Crossing Aipin Manteiga and Berat produced a fairly good percentage of 50.

When Copeland and Berat were crossed, the percentage of successful pollinations was also very low, 25.

Copeland and Aipin Manteiga gave 25 per cent successful pollination.

In studies made by Koch and Nichols as cited by Bolhuis,[5] the number of pollinations was often far too small, thus leading to misconception.

External morphology of seeds. The average size of 30 seeds was about 1.1 cm. long and 6 mm. wide. A cassava seed is somewhat flattened; the two ends are angular and the outer surface is concave (fig. 1e). It is grayish brown, somewhat shiny, with black and white spots.

Chromosome counts and cytological observations. Little detail could be seen in the chromosome units because of their small size. Only the metaphase stage allowed a satisfactory counting of the chromosomes. The bivalent chromosomes are best seen in the equatorial plate of first division, showing 18 bivalents in numerous counts.

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[4] N. B. Mendiola, "A Manual of Plant Breeding for the Tropics," Bureau of Printing, Manila, 1926, 365 pp.

[5] G. G. Bolhuis, *Med. Alg. Proefst. Landbouw. Buitenzorg, Java,* 9, 8 (1949).

Fig. 2.—Various aspects of the female and male flowers of normal cassava plants. (*Photographed by the Photographic Division.*)

Undoubtedly the small size of the chromosomes has been an important factor in the neglect of cytological studies of the genus. These data suggest that cassava varieties in this study are quite uniform in chromosome number. Graner, in a study of 38 cultivated varieties of Manihot grown in Brazil, found no deviation from a $2n$ number of 36.[6]

Somatic number of 36 chromosomes (fig. 3a) is expected of the root, and haploid counts of 18 in microsporocytes are expected of the gametes. The plant is said to be of diploid origin. Graner was able to verify a duplication of the number of chromosomes in a chimera spontaneously produced in the root tips.[7] Plants presumably have arisen from the union of reduced egg and sperm, that is, they are diploid by amphimixis. The plants that have appeared in progenies of cassava plants may be classified according to manner of origin as haploids, sexually produced diploids. The haploid individual is either of infrequent origin or fails to survive. The mother cells in these plants varied greatly in size, and their development failed to show

[6] E. A. Graner, *Univ. S. Paulo, Escol. Sup. de Agro. "Luis de Querioz,"* (1935).

[7] E. A. Graner, *Bragantia, San Paulo*, 2, 23 (1941).

the uniform characteristics of diploid plants. These conditions limited the study of chromosomes to the more normal cells.

Smears of the anthers with either aceto-carmine or aceto-orcein proved satisfactory for studying the meiotic stages. At the metaphase stage of one male flower bud, the chromosomes ranged them-

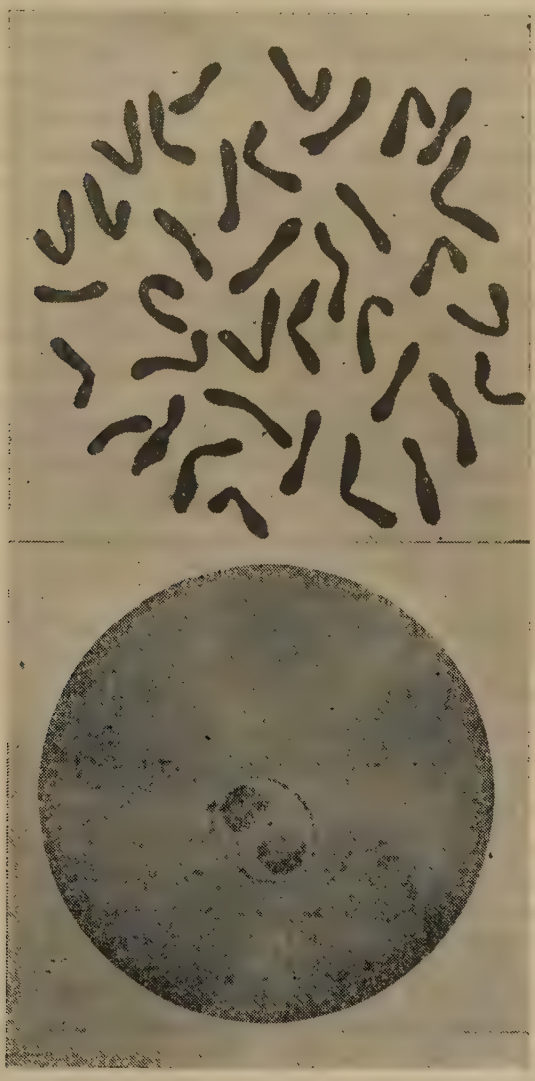

Fig. 3.—a. Somatic chromosomes from the root tip (enlarged); b. smear of the anther showing the pollen mother cells with metaphase plate. (*Photomicrographed by the Photographic Division.*)

selves in the equatorial plane. The metaphase plane was sometimes regular, but it appeared for a short duration as pure metaphase since some chromosomes readily pass on to the next stage (fig. 3b).

Although a closer study of the individual chromosomes is rendered difficult by the fairly large number (N 18) and the small size of the chromosomes, differences in size can still be demonstrated. In this investigation only a few somatic metaphase plates were inspected; an extensive study will perhaps make it possible to group the chromosomes and to characterize them according to size and place of constriction. In all the varieties of cassava, the 18 chromosomes paired during meiosis in the pollen mother cells. Though the number of varieties investigated was limited, the haploid chromosome number 18 was found very common.

Seed germination and seedling development. Germination was slow. The intact seeds, in some instances, did not germinate at all; in other instances, they took as long as four months to germinate. The percentages of germination after 13 and 21 days were very low (table 2). Germination is probably the most critical stage in the production of cassava hybrids.

TABLE 2.—*Germination of cassava seeds* [a]

CASSAVA VARIETY	NO. OF SEEDS	NUMBER OF SEEDS GERMINATED					PERCENTAGE GERMINATION AFTER	
		Feb. 2	Feb. 3	Feb. 5	Feb. 7	Feb. 10	13 days	21 days
Gariasa	132	1	1	1	1		1	3
Berat	76	1					1	1
Aipin								
Manteiga	56	2	4	2		4	4	21
Copeland	34		3	4	2		0	26
Vassourinha	30						0	0
Kekabu	12	1					8	8
Total	340	5	8	7	3	4		

[a] Sown January 21, 1954.

The effects of hot water treatment and rupturing the testa on seed germination are presented in table 3. Chandraratna and Nanyakkara stated that the early germination of testa-ruptured seeds indicates that dormancy is not the cause of delay in the germination of intact seeds.[8] Under ordinary conditions, when planted in seed

[8] Chandraratna and Nanyakkara, *op. cit.*

TABLE 3.—*Effects of hot water treatment and rupturing the testa on percentage of seed germination*

NO. OF DRUM	NO. OF SEEDS	TREATMENT [a]	GERMINATION AT END OF 4 WEEKS	GERMINATION AT END OF 6 WEEKS
1	27	Testa ruptured	44	67
		Hot water treatment	0	0
		Testa intact	33	56
2	27	Testa ruptured	33	78
		Hot water treatment	11	11
		Testa intact	44	67
3	27	Testa ruptured	56	67
		Hot water treatment	11	11
		Testa intact	11	22
4	27	Testa ruptured	44	78
		Hot water treatment	22	22
		Testa intact	22	78

[a] Nine seeds to each treatment.

drums shaded with banana leaves, the cassava seeds germinated after 13 days, but some germinated after 43 days or even later.

Seedlings were attacked by damping off fungus on February 7, 1954. Only three seedlings survived out of the eight seedlings that grew very close together. Seedlings should not be crowded.

About seven varieties and more than 109 seedlings were grown from January 21, 1954, to January 20, 1955. The variants found were classified according to the color of petiole and stem and the shape of the lobes. The number of these variants gives an idea of variability among the seedling progeny. It was further observed that the seedlings varied greatly in growth and development, degree of spread, height, leafiness, and color of leaflets.

Cassava can be improved in productivity, nutritive value, adaptability to soil and climate, association with other species, and palatability. Selection of the naturally crossed pollinated biotypes is the easiest method of improvement. Seeds were germinated, and after 283 to 288 days the plants showed signs of flowering. The average number of days from planting of seeds to blooming for the three varieties was from two to five days of each other.

The weights of the roots of the four varieties grown from seeds after nine months and eleven days can be found in table 4. Those

of diploid cassava roots grown from cuttings after nine months and fifteen days are shown in table 5. Gariasa, Berat, and Kekabu grown from cuttings flowered from 254 to 267 days.

TABLE 4.—*Weights of roots of varieties grown from seeds after 9 months and 11 days*

VARIETY [a]	WEIGHT IN KG.
Gariasa	3.4
Berat	2.6
Copeland	3.5
Aipin Manteiga	2.5

[a] Weights of roots of varieties based on number of roots they had.

It may be mentioned in this connection that ordinary cuttings and seedlings planted at the same time flowered simultaneously.

TABLE 5.—*Weights of roots of six varieties grown from cutlings after 9 months and 15 days*

VARIETY [a]	WEIGHT IN KG.
Gariasa	5.2
Berat	1.7
Kekabu	6.8
Copeland	6.3
Vassourinha	5.5
Aipin Manteiga	2.4

[a] Weights of roots of varieties based on number of roots they had.

SHEATH SPOT OF RICE [1]

RODRIGO B. VALDEZ

Sheath spot of rice in the Philippines caused by *Rhizoctonia solani* is very common in upland and lowland rice fields. The disease is of minor importance, but in warm, moist weather it causes spotting from the base up to the flagleaf of infected rice plants, resulting in stunting, arrested emergence of the panicle, and sterility of the grains.

The pathogen attacks rice plants at all stages of development. It is particularly injurious to plants that have not yet produced culms. The lesions are mostly on the leaf sheaths. Bandlike lesions occur on the leaves of thickly planted and lodging rice plants.

The fungus produces porous, tawny olive to Prout's brown sclerotia of irregular size and shape. The sclerotia remain viable for nine months when placed in a sterile flask and kept under laboratory conditions, eight months when buried 4 cm. deep in potted soil in the greenhouse, and six months when left in the open.

The disease may be controlled by burning the rice stubble and grasses after harvest, by not allowing irrigation water to pass through fields with diseased plants, by keeping the rice fields clean of weeds, by avoiding thick planting, and by using fungicides.

At present sheath spot of rice is not of much importance, but its presence on rice plants adds to the damage caused by other diseases such as blast and stem rot. This study designed to contribute to our knowledge of the disease, its cause, and possible control was conducted from December, 1953, to January, 1955, in the laboratory of the Department of Plant Pathology and in the rice fields of the Central Experiment Station and vicinity. The work was divided into the (1) study of the disease in the field and in the laboratory, (2) study of the morphological and physiological characteristics of the causal fungus, and (3) promulgation of control measures.

GEOGRAPHICAL DISTRIBUTION OF THE DISEASE

The occurrence of the sheath spot disease of rice in the Philippines was reported by Reinking (1918) and subsequently by Palo (1926). The same or a very closely related disease was reported in Louisiana, Arkansas, and Texas in the United States in 1933

[1] Central Experiment Station Contribution No. 1853. Thesis presented for graduation, March, 1955, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Plant Pathology under the direction of Research Assistant Professor Faustino T. Orillo.

(Ryker & Gooch, 1936). The disease is probably present in Japan and other rice-growing countries in the Orient although no reports have been published so far from those places. During the previous growing seasons, it was found on several upland and lowland varieties in the Central Experiment Station. The disease occurs in varying degrees of severity in lowland and upland varieties in the Maligaya Rice Experiment Station and the Lamao Experiment Station.

SYMPTOMS

Sheath spot of rice is characterized by rather large blotches with grayish-green, bluish-gray, or straw-colored centers and distinct brown borders on the leaves and leaf sheaths but never on the culms. The lesions are at first water-soaked, and in moist weather droplets of yellowish-brown liquid appear on the surface. The spots quickly enlarge and assume an elliptical shape. With age the lesions become bleached, producing straw-colored centers and a somewhat broad, reddish-brown margin with the deepest color next to the center. Under favorable conditions, the lesions may further enlarge and coalesce to form irregular discolored areas which may at times extend from the base of the plant to the flagleaf and even to the grains. Spots range from 0.4 cm. to more than 1.0 cm. long, with the width usually about one-half of the length. The lesions usually occur above the water line or on any part of the leaf sheaths and leaves. Abundant sclerotial bodies are formed on lesions during warm and moist weather. Lesions on leaves are similar to those of the banded sclerotial disease of sugar cane (fig. 1). The disease is usually prevalent in places where plant growth is dense and in low places where water usually accumulates. However, it may also appear on isolated plants.

THE CAUSAL ORGANISM

The fungus was easily isolated by the tissue planting method. Sections of fresh infected leaf sheaths 3 mm. sq. were disinfected with a 1:1000 mercuric bichloride solution, washed in three changes of sterile distilled water, and plated out on sterile potato-dextrose agar. After 24 to 48 hours at room temperature, transfers from the resulting hyphal growth were made on agar slants.

The fungus was also readily isolated by washing the infected tissues thoroughly with sterile distilled water and plating them out on acidified potato-dextrose agar. After 24 hours of incubation at room temperature, transfers were made on agar slants from the young hyphal growths.

Pure cultures were also obtained by planting sclerotial bodies on agar, with or without previous disinfection with 1:1000 mercuric bichloride solution. Fragments of the hyphae which grew from the sclerotial bodies were transferred to agar slants.

Fig. 1.—Specimens of rice showing lesions caused by *Rhizoctonia solani*. At extreme left are infected rice stems, one of them bearing sclerotial bodies; in the middle are infected rice panicles showing discolored and empty grains; and at extreme right are infected rice leaves showing bandlike lesions. (*Photographed by the Photographic Division.*)

MORPHOLOGY

Mycelium. In pure culture on most agar media and sterilized plant tissues, the causal fungus produces abundant mycelium which are superficial and submerged, hyaline to white, septate, thick-walled, very vacuolate when young, gradually becoming granular to clear when old. Measurements of 200 hyphal cells from 10-day-old cultures on potato-dextrose agar show that the cells are from 15.87 to 250.88 microns in length and 5.29 to 14.30 microns in width, the average size being $91.48 \pm 3.29 \times 9.11 \pm 0.11$ microns. The average ratio of length to width was 11:70.

A characteristic manner of branching of the fungus hyphae is readily observed in pure culture and in diseased tissues (fig. 2a).

Young hyphal branches develop generally at right angles from the main hyphal filaments with a clearly defined constriction at the point of branching. The septum is formed a short distance from the point of constriction. The main hypha is also septate a short distance near the branch. The branches subsequently bend in the direction of the growth of the parent hyphae. Fusion of hyphae is commonly observed in pure culture (fig. 2b). The hyphae on infected plant tissues are also superficial and internal and are intercellularly and intracellularly located.

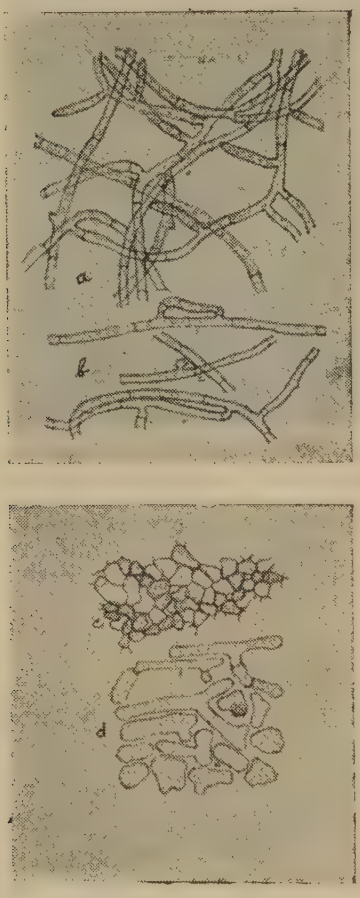

Fig. 2.—Camera lucida drawings of *Rhizoctonia solani*. Upper panel—a. mycelium taken from one-week-old potato-dextrose agar culture showing the typical method of branching, b. fusion of hyphal cells; lower panel—c. short, plump, barrel-shaped cells taken from one-week-old sclerotial body of the fungus; note the very granular appearance of the living cells and the dead and empty cells; d. short, much thickened, barrel-shaped cells taken from infected rice leaf sheath. (*Photographed by the Photographic Division.*)

Sclerotial bodies. As the fungus growth ramifies over the entire surface of the culture plate or slant, short, barrel-shaped, much-thickened cells are developed. These short-celled hyphae intertwine and anastomose, forming masses of sclerotial cells of various sizes

and shapes (fig. 2c & d). They are rigid and compact and eventually become the sclerotial bodies. These bodies are at first small, white, and soft but become brown and porous with age. Their porous nature is due to the oozing out of a yellowish-brown liquid on the outer surface as they mature. The sclerotia are spherical to ovoid from the top but slightly flattened underneath. On potato-dextrose agar slants, they are produced abundantly at the base where they coalesce and form crusty aggregations which are very irregular in shape. On oatmeal agar, the sclerotia are fairly distributed over the slant and are more or less uniform in size. When sclerotia are placed on sterilized soil, abundant new sclerotial bodies are formed. After a week, when the new sclerotial bodies have turned brown, sclerotial production ceases although the moist condition is maintained, indicating that sclerotial production is tied up with the available nutrients in the medium.

Under favorable conditions, it is possible that sclerotial bodies that drop from host plants may still produce abundant secondary sclerotial bodies on the ground and increase the source of inoculum. Ikata and Hitomi (1930) counted an average of 18.3 sclerotia in each of 30-sq. cm. areas in rice fields after harvest.

Measurements of sclerotial bodies from old cultures on several agar media and substrates show that they vary in size not only on different media but also on the same medium, a condition also observed by Palo (1926). Mature sclerotia produced on different media vary in color. On oatmeal agar, they are tawny olive; on potato-dextrose agar, Saccardo's Umber; and on steamed corn meal, Prout's brown. These colors are based on Ridgway's (1912) color standards and color nomenclature.

Palo (1926) states that on rice, sclerotia develop on dead tissues and never on living ones. The writer, however, observed sclerotial bodies on living tissues adjoining the lesions.

PHYSIOLOGY

Growth and production of sclerotial bodies on various agar media and substrates. The growth characteristics and production of sclerotial bodies of the fungus were studied on various agar media and substrates, namely, potato-dextrose agar, rice agar, rice decoction agar, corn meal agar, oatmeal agar, onion agar, coconut water agar, lima beans agar, malt agar, Czapek's agar, nutrient agar, young leaves of rice, rice stems, tomato stem, eggplant stem, young pods of lima beans, potato cylinders, sweet potato cylinders, radish cylin-

ders, *gabi* cylinders, sliced sugar cane, sliced papaya stem, sliced *patola,* sliced corn stem, and steamed corn meal. Triplicate cultures in test tubes were made for each medium and substratum. Two-week-old sclerotial bodies produced on potato-dextrose agar were planted at the center of each agar slant and substrate. The cultures were incubated at room temperature. Results are summarized in table 1.

Variations in abundance of mycelium and sclerotial production were observed on the different agar media and substrata. Sclerotial bodies were formed on potato-dextrose agar, coconut water agar, nutrient agar, oatmeal agar, Czapek's agar, tomato stem, sliced papaya stem, young pods of lima beans, sliced *patola,* radish, and *gabi* cylinders three days after inoculation; on malt agar, corn meal agar, lima beans agar, onion agar, rice agar, rice decoction agar, sweet potato cylinders, eggplant stem, rice stem, and young leaves of rice four days after inoculation; and on water agar, sliced corn stem, and sliced sugar cane five days after inoculation. On rice stems, sclerotial bodies were formed between the leaf sheaths, a phenomenon not observed in the field where sclerotial bodies are formed only on the leaves and leaf sheaths.

From the results of the experiment, it would seem that the more abundant the mycelium, the earlier and more abundantly sclerotial bodies are formed. It was further observed that the fewer the sclerotial bodies, the larger they become. When abundantly formed, however, they are small. These findings corroborate those of Allington (1936) who stated that "sclerotia do not form in Petri dish cultures until the growth of the organism is physically limited." He states further that this phenomenon occurs regardless of the size of Petri dishes used and that the age of culture is of little significance to sclerotial formation. The difference in age of sclerotial formation may, therefore, be explained on this basis.

It was also noted that the color of the sclerotial bodies varies with the different media. The writer believes that the color of the medium has something to do with the color of the sclerotial bodies.

Allington (1936) stated that in general, sclerotial development parallels vegetative growth and that growth rate and sclerotial formation decrease simultaneously with decrease in nitrogen. Cultures with high nitrogen invariably produce a heavy mycelial growth and demand more carbohydrates for maintenance. After the agar is completely covered, mycelial growth is slowed down considerably. At this time the assimilation of nitrogen is at a minimum and the assimilation of carbohydrates is still taking place at a relatively

TABLE 1.—*Effect of different agar media and substrata on size and production of sclerotial bodies of Rhizoctonia solani*

MEDIUM OR SUBSTRATE	NUMBER OF SCLEROTIAL BODIES MEASURED	SIZE IN MILLIMETERS	RELATIVE ABUNDANCE OF	
			Mycelium	Sclerotial bodies
Potato-dextrose agar	50	0.96–2.65 × 1.14–3.58	Abundant	Abundant
Corn meal agar	41	1.03–2.93 × 1.19–4.26	Abundant	Fairly abundant
Oatmeal agar	50	1.10–3.12 × 1.33–5.11	Abundant	Abundant
Rice decoction agar	50	0.80–2.02 × 1.04–3.04	Fairly abundant	Abundant
Rice agar	39	0.68–2.29 × 1.02–3.05	Fairly abundant	Few
Onion agar	50	0.85–3.94 × 1.24–6.16	Fairly abundant	Abundant
Coconut water agar	50	0.64–3.56 × 0.98–5.05	Abundant	Abundant
Water agar	25	0.52–2.07 × 0.70–2.37	Few	Very few
Lima beans agar	39	0.51–2.63 × 1.17–3.85	Abundant	Few
Malt agar	50	1.04–3.12 × 1.37–4.57	Fairly abundant	Fairly abundant
Czapek's agar	50	1.22–3.16 × 1.56–3.87	Fairly abundant	Abundant
Nutrient agar	50	0.81–3.44 × 0.96–4.84	Fairly abundant	Fairly abundant
Young leaves of rice	30	0.91–2.36 × 1.22–3.41	Fairly abundant	Few
Rice stems	50	0.47–2.26 × 0.81–3.07	Fairly abundant	Fairly abundant
Tomato stem	50	0.69–2.89 × 1.10–4.08	Abundant	Abundant
Eggplant stem	50	1.16–3.16 × 1.49–6.28	Abundant	Abundant
Young pods of lima beans	50	1.12–4.18 × 1.34–6.92	Abundant	Abundant
Potato cylinders	50	1.02–2.81 × 1.27–4.34	Abundant	Abundant
Camote cylinders	50	1.23–4.13 × 1.38–5.21	Abundant	Abundant
Radish cylinders	30	1.09–2.80 × 1.38–4.36	Abundant	Few
Gabi cylinders	50	1.19–7.51 × 1.38–8.88	Abundant	Abundant
Sliced sugar cane	37	0.98–3.94 × 1.28–6.22	Few	Very few
Sliced papaya stem	50	0.77–2.59 × 0.85–3.20	Abundant	Abundant
Sliced patola	50	1.06–2.79 × 1.31–5.40	Abundant	Abundant
Sliced corn stem	28	0.73–2.27 × 0.94–2.88	Few	Very few
Steamed corn meal	50	1.23–4.69 × 1.36–6.56	Abundant	Abundant

high rate. The demand for carbohydrates is greater than for nitrogen; hence, the decrease in carbohydrates is first to have an effect. Montieth and Dahl report that the type and color of sclerotia fluctuate with different degrees of acidity (Allington, 1936).

Growth and production of sclerotial bodies on media of different hydrogen-ion concentrations. To determine the effects of different hydrogen-ion concentrations on the mycelial growth and production of sclerotial bodies, the fungus was grown on potato-dextrose agar at different pH levels. The pH of the medium, ranging from 3.0 to 9.5, was adjusted with the aid of a La Motte colorimeter. Triplicate cultures were made for each pH. The sclerotial body used as inoculum for each plate was selected so that the size was approximately the same for all the plates. All cultures were kept at ordinary room temperature. The diameter of the colonies was measured on the second, third, and fourth days after inoculation. The last growth measurement was made on the fourth day because by that time the cultures under favorable pH conditions had covered the entire surface of the agar media. The relative abundance of aerial mycelium was finally observed on the fifth day, and the relative abundance of sclerotial bodies, after two weeks. The results of the experiment are summarized in table 2.

TABLE 2.—*Effect of pH on growth and production of sclerotial bodies of Rhizoctonia solani*

pH	DIAMETER OF COLONY AFTER 4 DAYS [a]	AVERAGE DAILY GROWTH	RELATIVE ABUNDANCE OF	
			Aerial mycelium	Sclerotial bodies
	mm.	*mm.*		
3.0	40.7	10.2	Scanty	Very few
3.5	84.3	21.1	Scanty	Very few
4.0	90.0	22.5	Fairly abundant	Few
4.5	90.0	22.5	Abundant	Fairly abundant
5.0	90.0	22.5	Abundant	Fairly abundant
5.5	90.0	22.5	Abundant	Fairly abundant
6.0	90.0	22.5	Abundant	Abundant
6.5	90.0	22.5	Abundant	Abundant
7.0	90.0	22.5	Abundant	Abundant
7.5	90.0	22.5	Abundant	Abundant
8.0	90.0	22.5	Abundant	Fairly abundant
8.5	90.0	22.5	Fairly abundant	Fairly abundant
9.0	65.0	16.2	Scanty	Very few
9.5	54.0	13.5	Scanty	Very few

[a] Average of 3 cultures.

The optimum pH range for growth and sclerotial development was from pH 4.0 to 8.5. Very slow growth was observed at pH 3.0 and 3.5 and at pH 9.0 and 9.5. The type of growth and size of colony at these pH levels were almost the same. The hyphae were short-celled and mostly grew vertically rather than radially. Early production of sclerotial bodies was also observed at these pH although very few were formed. Sclerotial bodies were formed three days after inoculation at pH 5.5 to 8.5 and four days after at pH 4.0 and 4.5.

Generally, in all the cultures, sclerotial bodies were formed abundantly along the periphery of the plates. When abundantly formed, they were small, but when few they were large.

Methods of inducing spore production. In an attempt to induce the fungus to sporulate, five methods were tried. In these experiments, the fungus was grown on plated potato-dextrose agar. The cultures that were placed in the incubator, refrigerator, and freezer were grown on potato-dextrose agar slants. To determine further the effect of these treatments on the production of sclerotial bodies, the fungus was subjected to the different treatments before sclerotial bodies were formed. Five Petri dish and five agar slant cultures were made for each treatment, and the same number was maintained as checks kept under ordinary laboratory conditions. Cultures were treated after an incubation period of 48 hours.

(1) Exposure to sunlight of cut fungus mycelium—The fungus mycelium, together with the agar, was cut aseptically into blocks about 1½ cm. square. Three plate cultures were exposed to the sun from 7:00 a.m. to 4:00 p.m., and two were placed in the laboratory at room temperature.

(2) Growing the fungus in a desiccator—The 48-hour-old plate cultures were placed in a desiccator for a week.

(3) Alternate exposure of cultures to light and dark—The plate cultures were placed in a black-painted box. A 100-watt electric bulb supplied the artificial light, and the dark condition was obtained by putting out the light and completely closing the box. For 48 hours the cultures were alternately exposed to 3-hour periods of light and dark. The distance of the culture plates from the bulb was about 1 foot, and the temperature during the period of exposure to light was 39°C.

(4) Treating the cultures with dilute solution of poisonous substances—Three drops each of chloropicrin, formaldehyde, phenol, and

0.1 per cent $CuSO_4$ solution were placed on the cultures, which were shaken thoroughly to spread the poison over the fungus growth. Five culture plates were used for each of the substances. Afterwards the cultures were kept under ordinary laboratory conditions.

(5) Exposure of cultures to low and high temperature—Five each of the slant cultures were kept in an incubator at 37°C., in a refrigerator at 9°C., and in a freezer at −4°C. for one week.

After the cultures were subjected to the different treatments, they were examined under the microscope weekly for three weeks. None of the treatments induced basidiospore formation; however, they exhibited different effects upon sclerotial formation. No sclerotial bodies were produced on cultures exposed to the sun and on those treated with poisonous substances. Cultures placed in the desiccator produced profuse mycelium but no sclerotial bodies during the treatment. Abundant sclerotial bodies, however, were formed when these cultures were removed from the desiccator. The cultures exposed to alternate light and darkness did not form sclerotial bodies during the treatment but produced abundant sclerotial bodies afterwards. Those placed in the incubator and in the refrigerator produced very few sclerotial bodies during the treatment. The mycelial growth of cultures placed in the freezer was checked. Sclerotia were not produced during the treatment but were produced later when the cultures were taken out.

Viability of mycelium and sclerotial bodies. To test the ability of the fungus mycelium and sclerotial bodies to tide over from season to season, experiments were carried out to determine their viability at different ages.

The viability of mycelium in infected rice leaf sheaths was determined in two sets of experiments, the first starting on January 27, 1954, and the second, on March 3, 1954. In both sets of experiments the same procedure was followed.

Diseased rice leaf sheaths were collected from the Central Experiment Station rice field and divided into two lots. The first lot was exposed to field conditions, and the second was kept in covered mason jars in the laboratory. The infected sheaths in the first lot were cut into sections 2 to 3 inches long, incorporated with previously autoclaved soil, and covered 2 cm. deep. The soil was contained in halved kerosene cans. One set was placed in the open, and the other, in the greenhouse. From the two lots, fragments of the infected leaf sheaths were taken at one-month intervals and tested

for the viability of the mycelium by the tissue planting method. The surface-sterilized sections of the leaf sheath were planted on plated potato-dextrose agar and incubated at room temperature for 72 hours. This length of incubation period was found to be sufficient when the mycelium within the leaf sheath sections was still viable.

The results of the experiment showed that the fungus mycelium remained viable in the leaf sheath for more than a month when incorporated with the soil. When it was placed in covered glass containers in the laboratory, however, no growth was observed after two months.

In the determination of the viability of sclerotial bodies, two sets of experiments were also conducted. On March 7, 1954, three-week-old sclerotial bodies produced on oatmeal agar were collected. The first lot was placed in a sterile Erlenmeyer flask plugged with cotton, and the second lot was buried 4 cm. below the surface of dry, potted, sterilized soil. Two pots were prepared; one was placed in the greenhouse and the other was exposed to the weather in the open.

The viability of the sclerotial bodies was also determined by growing them on potato-dextrose agar at one-month intervals. The sclerotial bodies were washed thoroughly with tap water to remove the soil particles, surface-sterilized with 1:1000 mercuric bichloride solution, washed in three changes of sterile distilled water, plated on potato-dextrose agar, and incubated at room temperature for 49 hours.

The experiments showed that under laboratory conditions the fungus can remain viable up to nine months; under greenhouse conditions, eight months; and when exposed to the weather in the open, six months.

PATHOGENICITY

To prove the pathogenicity of the fungus, the following methods of inoculation were used: (1) smearing the mycelium together with portions of the media on the surface of the leaf sheaths and leaves of rice plants, (2) spraying a suspension of mycelial fragments in sterile water on the vegetative parts of the plants, (3) placing the sclerotial bodies on and between the leaf sheaths, (4) planting disinfected rice seeds in pots of sterilized soil mixed with sclerotial bodies, (5) planting disinfected rice seeds in pots of sterilized soil mixed with infected leaf sheaths.

In all inoculation experiments Wagwag and Guinangang rice varieties were used. In the first three methods, the plants were

inoculated at different growth stages using different sets of plants, whereas in the last two methods the soil was infested once.

Experiment 1. In the experiment using methods 4 and 5, the plants were planted on the same date. On April 8, 1954, five hundred rice seeds of the variety Wagwag were disinfected with 1:1000 mercuric bichloride solution for 5 minutes and washed in three changes of sterile distilled water. The seeds were planted in twenty 8-inch pots of sterilized soil, 25 seeds to a pot. One hundred twenty-five seeds were planted in five pots which were infested with three-week-old sclerotial bodies, and 125 seeds were planted in five pots of sterilized soil alone to serve as check. Another 125 seeds were planted in five pots infested with cut diseased rice leaf sheaths, and 125 seeds in five pots of soil incorporated with healthy rice leaf sheaths. The plants were grown in the greenhouse.

The rice seeds germinated five to six days after planting. On the pots infested with sclerotial bodies, abundant mycelial growth was observed two days after the soil was infected, and after three days young sclerotial bodies were formed on the surface of the soil. On the fifth day after planting, when the seedlings began to germinate, mycelium abounded at the base of the seedlings, and sclerotial bodies were produced on some of them. Two days after germination, symptoms of the disease were observed. Water-soaked lesions appeared at the base of the seedlings, which finally turned brown after five to six days. The mycelial growth ramified over the tips of the seedlings and caused stunting and death of some of the plants. Heavily infected seedlings fell over. Some, however, were able to survive by producing secondary shoots. The seedlings that survived continued to grow, but the production of abundant lesions on the leaf sheaths and leaves continued.

No symptoms were observed on the plants growing in soil with diseased leaf sheaths. The mycelium might have also grown but were not sufficient to infect the seedlings. These experiments were repeated on November 28, 1954, and similar results were obtained. In both experiments control plants remained healthy.

Experiment 2. On April 7, 1954, rice seeds of variety Guinangang, obtained from the Department of Agronomy, were planted in eight pots of soil. The soil was taken from a place supposedly free from *Rhizoctonia* infection. The potted rice plants were placed beside the greenhouse.

When the plants were 30 days old, they were inoculated by means of the first three methods. In this experiment 15 plants were

maintained in each pot. Five potted rice seedlings each were inoculated and five potted plants were used as check. The same number of pots and plants were used for inoculation during the prebooting, booting, and milk stages of the plants. The other inoculation experiments were done when the plants were 90, 112, and 126 days old, respectively.

After the inoculation of the plants at the prebooting stage, the remaining plants suffered from Cercospora leaf spot and borer infestation. Healthy plants were reduced in number so that it was necessary to have another planting.

On September 13, 1954, one-month-old rice seedlings of variety Guinangang were transplanted to 40 pots, 15 seedlings to each pot. On November 4, 1954, when the plants were at the booting stage, they were inoculated. Another inoculation was done on November 24, 1954, when the plants were at the milk stage.

In every case, the inoculated and check plants were kept for 72 hours in the moist chamber and then transferred to the shade outside the laboratory for further observation.

In all the inoculation experiments positive results were obtained. Generally, the earliest symptoms of the disease were discernible 24 hours after inoculation although in the method where sclerotial bodies were used as inoculum, symptoms were observed 15 hours after inoculation. Infection was evidenced by the appearance of water-soaked lesions at the points where the inoculum was applied. After 72 hours of inoculation, the inoculated plants in the seedling and prebooting stages were severely infected. The plants wilted and their tops toppled over due to the rotting of the stems. Fluffy growth of mycelium hang on the leaves and stems (fig. 3).

On plants inoculated at the booting and milk stages, severe infection was also observed after 72 hours (fig. 3), but because of the tough straw already produced by the plants, the tops fell over only occasionally. Large water-soaked lesions were produced on the leaf sheaths and leaves. These became evident after five days and were typical of the lesions observed on plants in the field. When the inoculum was placed on the peduncle of the panicle, the panicle fell over and filling of the grains was prevented. When it was placed on the leaf sheath that enveloped the grains, it caused discoloration of the grains. In some cases the panicle was prevented from coming out by the mycelial mat that pasted the leaf sheaths and the grains together.

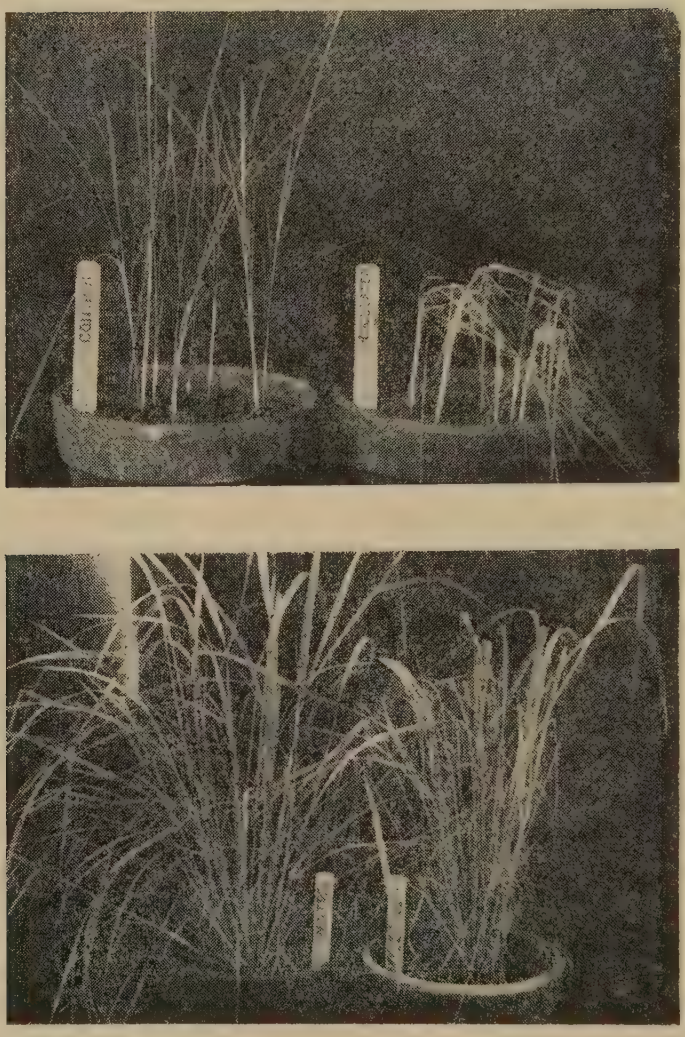

Fig. 3.—Upper panel, inoculated and control 30-day-old rice seedlings grown in pots of sterilized soil. Inoculation was done by smearing the stems and leaves with the fungus mycelium together with a portion of the medium; control plants were sprayed with sterile distilled water. The inoculated plants fell over and were covered with long strands of mycelium. Lower panel, potted rice plants inoculated with sclerotial bodies of *Rhizoctonia solani* on and between the leaf sheaths at the booting stage. Note the drying of the leaves and leaf sheaths of the inoculated plants as a result of infection. (*Photographed by the Photographic Division.*)

The results of the experiment showed that the fungus is capable of infecting the rice plants at any age. Rice plants at different growth stages may be equally susceptible, but the damage on younger plants is more severe as their tissues are still succulent and favor penetration of the fungus hyphae. The disease is commonly observed on the leaf sheath and leaves and occasionally on the emerging panicle, but in no case is it observed on the straw, except on seedling plants in both upland and lowland rice fields.

After every inoculation test, reisolations were made as soon as the plants showed typical symptoms of the disease. In all cases the reisolated fungus proved to be the same as the original stock culture. Inoculation tests proved that the reisolated cultures were just as pathogenic as the parent cultures.

Varietal susceptibility and resistance. The writer observed differences in degree of infection among the upland and lowland rice varieties grown in the College and vicinity and in Calamba. To confirm this observation, an inoculation experiment on different rice varieties was made.

On September 5, 1954, fourteen varieties of upland rice (Binicol, Carti, Canoni, Fortuna, Guinata, Inintiw, Kinanda, Kinandang Puti, Makapilay Pusa, Palawan, Magsanaya, Serrano Nos. I and II, and Sinaguing) were planted in sterilized potted soil. Five pots were planted to each variety and 12 seedlings were maintained in each pot. To avoid possible infection with other rice diseases, the plants were grown in the greenhouse.

The varieties were inoculated at the booting stage. For each variety, three pots were inoculated and two were used as check. Sclerotial bodies were used as inoculum. Inoculated plants were incubated in the moist chamber for 48 hours.

On most of the varieties, symptoms were observed 15 hours after inoculation. After 48 hours, the plants were removed from the moist chamber and placed in the shade for further observation. Typical, large, coalesced lesions were observed on the leaves and leaf sheaths after five days.

Of the 14 varieties tested, only Inintiw and Macapilay Pusa proved to be fairly resistant to the disease. On these two varieties symptoms occurred later and the number of lesions were less. All the others, including Guinangang and Wagwag which were used in

previous experiments, were equally susceptible. In these tests, the disease reactions of the above-mentioned varieties were similar to those observed in the field.

Host range. Several species of *Rhizoctonia* are known to have a wide host range. To determine whether the *Rhizoctonia* causing sheath spot of rice can infect plants other than rice, cross-inoculation experiments were conducted.

Different species of weeds commonly found in upland and lowland rice fields were transplanted to pottted soil in the greenhouse. When the plants were already established in the pots, they were inoculated with two-week-old sclerotial bodies. Some of them were sprayed with mycelial suspension. Check plants were sprayed with sterile distilled water. Both inoculated and check plants were incubated in the moist chamber for 72 hours and then transferred to the shade outside the laboratory for further observation.

All 12 species belonging to eight genera of Gramineae and one genus of Cyperaceae were infected by the rice sheath spot fungus. These species [2] are listed in the order of their susceptibility. Lowland: *Ischaemum rugosum* Salisb., *Echinochloa colonum* (L.) Link, *Echinochloa crusgalli* Beauv., *Echinochloa stagnina* (Retz.) Beauv., *Panicum repens* L., *Panicum auritum* Prese., *Paspalum scrobiculatum* L., *Cynodon dactylon* (L.) Pers.; upland: *Digitaria sanguinalis* (L.) Scop., *Imperata cylindrica* (L.) Beauv., *Cyperus rotundus* L., and *Eleusine indica* (L.) Gaertn.

Cross-inoculation experiments were also made on sugar cane (*Saccharum officinarum* L.), corn (*Zea mays* L.), peanut (*Arachis hypogaea* L.), soybeans (*Glycine max* (L.) Merr.), string beans (*Vigna sesquipedalis* W. F. Wight), pepper (*Capsicum annuum* L. var. *longum* Bendt.), tomato (*Lycopersicon esculentum* Mill.), and eggplant (*Solanum melongena* Linn.). On sugar cane the lesions produced were typical of the banded sclerotial disease. On string beans, pre-emergence damping-off, collar rot, and severe blighting were observed (fig. 4). Nacion (1926) and Malaguti (1951) observed similar results on beans inoculated with *Rhizoctonia solani.* Severe infection was observed on all the inoculated plants after 72 hours of inoculation in the moist chamber.

[2] Identified by Mr. Juan V. Pancho of the Department of Agricultural Botany.

Fig. 4.—Inoculated and control 10-day-old string bean seedlings grown in sterilized soil. Inoculation was done by spraying with mycelial suspension of *Rhizoctonia solani*. Control plants were sprayed with sterile distilled water. The plants were placed in the moist chamber for 48 hours, then transferred to the shade and photographed 2 days later. (*Photographed by the Photographic Division.*)

TAXONOMY

A comparison of the morphological and physiological characters of the *Rhizoctonia* causing sheath spot of rice in the Philippines with those of other species of *Rhizoctonia* shows that the Philippine fungus closely resembles *Rhizoctonia solani* as reported by Palo (1926). The symptoms produced by this fungus on rice are indistinguishable from those produced by *Rhizoctonia* spp. reported in Japan, India, and other Oriental countries and in Louisiana and Texas. However, on sugar cane and beans the symptoms are very typical of those produced by *Rhizoctonia solani* (Nacion, 1924; Bell, 1929; and Malaguti, 1951). In view of these considerations, the writer considers the Philippine rice sheath spot fungus as identical with *Rhizoctonia solani* Kühn. studied on rice first by Reinking (1918) and later by Palo (1926).

LIFE HISTORY OF THE CAUSAL FUNGUS IN RELATION TO PATHOGENESIS

Seasonal occurrence of the disease. Observations in both upland and lowland rice fields in the Central Experiment Station and vicinity showed that the sheath spot disease of rice appears any

time during the year where rice is grown. The highest incidence of the disease, however, was observed in August and September on upland varieties and in December and January on lowland varieties, when the plants are at the prebooting stage up to the dough stage.

Methods of penetration. To determine the methods of penetration of the fungus, sections of rice leaves and sheaths with incipient lesions were cut, decolorized in a 50:50 solution of glacial acetic acid and 95 per cent ethyl alcohol, and stained with Pianeze III b. Microscopic examinations showed that the hyphae can enter the host tissues either directly through the epidermis or through stomatal openings.

Methods of living over adverse conditions. Previous experiments have shown that the sclerotial bodies of the fungus can live for long periods even when exposed to weather conditions, whereas the mycelium can live for relatively much shorter periods in infected plant tissues. From this it is evident that the fungus tides over adverse conditions by means of its sclerotial bodies.

Methods of dissemination. Sclerotial bodies of the fungus may be abundantly produced on host plants in the field. At maturity they easily fall to the ground, especially during harvest. They may then be carried from infested to noninfested fields with the hay, straw, grasses, and other plant materials. They may adhere to the farm implements during land preparation. Heavy rains, irrigation water, and small floods are also agents in the dissemination of the fungus. Typhoons are often accompanied by hard rains which cause the rice plants to lodge and the leaves to overlap each other. Under moist conditions the mycelium may grow rapidly from plant to plant. This method of spread is very effective when plants are set close together. Insects which feed on the host plants may carry with them mycelial fragments from infected to healthy plants and thus spread the disease.

Sources of inoculum. Remains of infected rice plants containing sclerotial bodies left in the field after harvest may serve as source of inoculum for the succeeding rice crop.

Certain grass weeds commonly growing in rice fields have been found to serve as natural hosts of *Rhizoctonia solani.* Among them are the 12 species of grasses which were used in the previous cross-inoculation experiment. In the absence of rice in the field, the fungus thrives well on these weeds. Abundant sclerotial bodies may

be produced on them, and these in turn cause the initial infection of rice planted in the same area.

CONTROL MEASURES

1. The infected rice stubble and straw lying on the ground and the grasses bordering the field should be burned thoroughly as soon as the crop is harvested. This measure will minimize the spread of the disease to noninfested fields. It is often difficult to do this on wet land, but where "surface firing" is possible, this measure may be effective.

Park and Bertus, as cited by Padwick (1950), recommended the marking out of areas containing diseased plants including a border of apparently healthy plants before harvesting. Such plants should not be harvested but should be burned as soon as possible after harvest of the noninfested areas.

2. Irrigation water should not be allowed to pass through fields containing diseased plants as the sclerotial bodies are easily disseminated by water.

3. Rice fields should be kept clean of weeds. It is necessary that grass weeds in and near the field be removed as most of the grass weeds common in rice fields are hosts of the pathogen.

4. Thick planting should be avoided. Thick planting favors the growth of *Rhizoctonia* because it keeps the soil and air between the plants moist. This condition also facilitates the spread of the fungus from one plant to another.

5. Fungicides may be used.

An experiment was conducted in the laboratory to determine the effectiveness of eight commercial fungicides against the sheath spot fungus. Arasan SF-X, Granosan, Ceresan M., and Tersan were sprayed at the rate of 0.5 gram per liter; Orthocide and Manzate, 2.5 grams per liter; Panogen, 1:5000; Dithane D-14, 4 ml. + 1 gram Zinc sulfate per liter. Six pots of 20 plants each were sprayed with each fungicide, and six pots of the same number of plants were sprayed with tap water as check. Triton B-1956, a wetting agent, was mixed with the spray to insure thorough coating of the plants. When the sprayed plants were thoroughly dry, they were inoculated with three-week-old sclerotial bodies and then placed in the shade to prevent dilution of the spray concentration. Final observations were made 16 days after inoculation.

The results of the experiment show that the fungicides at the concentrations used did not completely prevent infection. However, Orthocide and Manzate appear to be more effective than the others. Further work on rate and frequency of application of these fungicides should be done in order that their effectiveness against sheath spot of rice can be properly evaluated.

LITERATURE CITED

ALLINGTON, W. B. 1936. Sclerotial formation in *Rhizoctonia solani* as affected by nutrition and other factors. Phytopath. 26: 831-844.

BELL, ARTHUR F. 1929. A key for the field identification of sugar cane diseases. Bu. Sugar Exper. Sta., Queensland, Bull. No. 2.

IKATA, S., AND T. HITOMI. 1930. On the mode of primary infection through sclerotia and field observations on the basidiospore formation in *Hypochnus sasakii* Shirai of rice plants. Jour. of Plant Protection 27: 1-2. (Japanese with English summary. Abst. in Rev. App. Mycol. 10: 55).

MALAGUTI, G. 1951. Mancha de la hoja envaindadora del arroz causado por *Rhizoctonia solani* [Sheath spot disease of rice caused by *Rhizoctonia solani*]. Agron. Trop., Macaracay 1: 71-75. (English summary).

NACION, C. C. 1924. Study of *Rhizoctonia* blight of beans. Philippine Agriculturist 12: 315-321.

PALO, M. A. 1926. *Rhizoctonia* disease of rice: I. A study of the disease and of the influence of certain conditions upon the viability of the sclerotial bodies of the causal fungus. Philippine Agriculturist 15: 361-375. *Pl. 1-4.*

PADWICK, G. WATTS. 1950. Manual of rice diseases. The Commonwealth Mycological Institute, Kew, Surrey.

REINKING, O. A. 1918. Philippine economic-plant diseases. Philippine Jour. Sci. 13, Sec. A: 165-274. *Pl. 1-22, fig. 1-43.*

RIDGWAY, ROBERT. 1912. Color standards and color nomenclature. iii + 43 p., 53 pl. Washington D.C.: Robert Ridgway.

RYKER, T. C., AND F. S. GOOCH. 1938. *Rhizoctonia* sheath spot of rice. Phytopath. 28: 233-246.

RESPONSE OF CORN TO FERTILIZATION IN THREE SOUTHERN LUZON PROVINCES [1]

N. L. Galvez, S. N. Tilo, J. G. Davide, M. E. Raymundo, and P. A. G. Santos

Lipa loam in Lalakay, Los Baños, in Maquiling, Calamba, in College, and in Sto. Tomas, Quingua fine sandy loam in Bañadero, Calamba, Ibaan loam in Pinagtungulan, Lipa City, and Guadalupe clay in Muntinlupa all responded to nitrogen. Quingua fine sandy loam needed potassium in addition to nitrogen. Guadalupe clay needed phosphorus in addition to nitrogen.

For loam soils an increase of 13 to 36 cavans of shelled corn per hectare was obtained from the use of 45 kg. N. The application of 45 kg. N with 90 kg. P_2O_5 to Guadalupe clay increased the yield by 20 cavans. Loam soils are significantly better than clay soils. The failure of phosphorus fertilizer to increase the yield of corn in Lipa loam is due to its sufficient amount in the soil and not to position. Soil reaction and exchangeable bases of Lipa loam around Mount Maquiling were not the critical factors for corn production. The organic matter content was not a sufficient source of nitrogen for corn.

Lighter soil was suggestive to potassium fertilization although its potassium content was comparatively higher than that of the heavier soils.

Practically all cultivated soils in this area have been under intensive cultivation for at least fifty years; hence, their available nitrogen, phosphorus, and potassium have continuously been removed by crops and leached by heavy rains.

The cheapest and most practical way of replenishing the lost fertility is by using fertilizers. Inasmuch as crop response to application of fertilizers is the resultant effect of the interaction between soil-fertilizer-crops and the other factors in crop production, conducting field experiments right in the problem area is the logical way of determining the effects of nitrogen, phosphorus, and potassium on the yield of crops and their chemical composition.

Soil researches implemented in cooperation with farmers give them a chance to discover the disadvantages of their obsolete meth-

[1] Central Experiment Station Contribution No. 1854. This project was planned on the advice of Dr. N. C. Brady, former visiting professor of soils (1953-1954). Part of the expenses were from a Mathieson-Menzi research grant. Statistical computations were done in the Division of Statistics.

ods of farming and at the same time realize the benefits which may be derived from correct management of cropping.

Although the voluminous work on corn fertilization in the United States and other countries is a source of valuable information, it can not be used as an absolute basis for fertilizer recommendations on corn in the Philippines because of soil and climatic differences. While literature on the fertilization of corn in the Philippines is already extensive, only very limited conclusions can be formed as practically all of the experiments were conducted in the UP College of Agriculture. Some of these previous studies are those by Camus (1914), Montellano (1916), Barros (1940), Madrigal (1941), Calma and Castro (1950), and Eusebio and Umali (1952).

MATERIALS AND METHODS

Field trials on the efficiency of nitrogen, nitrogen-phosphorus, and nitrogen-phosphorus-potassium fertilizers in increasing the yield of Yellow Flint corn were carried out in representative corn fields in the provinces of Laguna, Batangas, and Rizal in cooperation with farmers.

Nitrogen was supplied as ammonium sulfate and ammoniated superphosphate; phosphorus, as ammoniated superphosphate and superphosphate; and potassium, as muriate of potash.

In all treatments phosphate and potassium and one-half of the nitrogen were added at the time of planting. The rest of the nitrogen was added before hilling.

RESULTS AND DISCUSSION

General observations. As expected, the plants in the nitrogen-treated plots were darker green, taller, and had bigger stems than those in the other plots. The improvement in the appearance of the plants was associated with the rates of nitrogen application. This was especially apparent in the stand of plants in the provinces of Batangas and Laguna. No distinct response to potassium was noted.

Response to fertilization in Laguna. Lipa loam in Lalakay, Los Baños, was highly responsive to the addition of nitrogen but not even suggestive to phosphorus and potassium (table 1). The average yield of fresh roasting corn ears was increased from 1,685.5 to 3,967.8 kilograms per hectare with the addition of 45 kg. N. Ninety kilograms N gave an average yield of 4,515.9 kilograms, which was

better than that produced by 45 kg. N, pointing out the need for testing the next higher rates of nitrogen.

TABLE 1.—*Response of corn to fertilization in Laguna*

SOIL TYPE AND LOCATION	N TREATMENT	P-K TREATMENT -0-0	-90-0	-90-90	AVERAGE YIELD	RESPONSE TO
		yield in kilograms of roasting corn ears/ha.				
Lipa loam	0	1,694.2	1,794.5	1,567.8	1,685.5	
Lalakay, Los Baños	45	4,023.9	3,859.4	4,020.0	3,967.8	Nitrogen
CF-1 [a]	90	4,277.8	4,458.1	4,811.8	4,515.9	
Average		3,332.0	3,370.7	3,466.5		
SMD (N) 5%—297; 1%—401						
		yield in kilograms of roasting corn ears/ha.				
Quingua fine sandy loam	0	1,611.4	1,680.2	2,749.2	2,013.6	
Bañadero, Calamba	22.5	3,100.2	2,984.4	4,703.6	3,596.1	Nitrogen and
CF-2 [a]	45	2,852.0	3,241.9	4,957.6	3,683.8	potassium
Average		2,521.2	2,635.5	4,136.8		
SMD (N) 5%—386; 1%—523						
(P, K) 5%—407; 1%—592						
		yield in cavans per hectare (15% moisture)				
Lipa loam	0	16.3	31.8	14.1	20.7	Nitrogen
Maquiling, Calamba	45	38.5	38.7	24.1	33.8	and phos-
CF-4 [a]	90	41.5	47.3	27.4	38.7	phorus but
Average		32.1	39.3	21.9		negative to potassium
SMD (N) 5%—5.07; 1%—6.83						
(P, K) 5%—4.79; 1%—6.82						

		yield in cavans per hectare (15% moisture)								
		A	B	A	B	A	B	A	B	
Lipa loam	0	35.0	14.6	37.8	20.9	45.6	24.4	39.5	20.0	
College of Agriculture	45	63.7	48.4	80.8	46.3	81.0	45.2	75.2	46.6	Nitrogen A Nitrogen B
CF-9A, 9B	90	83.1	46.8	90.3	58.7	82.7	57.5	85.3	54.3	Phosphorus B
Average		60.6	36.6	69.6	42.0	69.8	42.4			
SMD (N) A 5%—8.41; 1%—11.33										
SMD (N) B 5%—6.3; 1%—8.5										
(P, K) 5%—4.5; 1%—6.4										

A—wet-season crop; part of thesis of C. Barile, J. Caingcoy, and C. P. Mamaril (1955); B—dry-season crop.

[a] Part of theses of A. C. Alba, Jr., G. Manza, and E. A. Clemente (1955).

It was also observed that the increase in yield was accompanied by an increase in the proportion of saleable ears. The control showed

an average of 3 per cent large ears, and the nitrogen plots, 31 to 43 per cent, depending upon the rate of nitrogen.

Quingua fine sandy loam in Bañadero, Calamba, like Lipa loam in Lalakay, markedly increased in yield with nitrogen treatment. The application of 22.5 kg. N per hectare increased the average yield from 2,013.6 to 3,596.1 kg. fresh weight of roasting corn ears. The 45-kg. N rate yielded only as much as the 22.5-kg. N rate. It was also apparent from the data that there was a significant response to potassium but none to phosphorus, suggesting that N-K treatment should be tested with others.

Lipa loam in Maquiling, Calamba, showed a highly significant improvement in yield of shelled corn. The 45-kg. N rate gave an increase of 13.1 cavans, which was more than the SMD at 1 per cent level. On the other hand, the 90-kg. N rate gave an average yield of 38.7, which was not statistically better than that of the 45-kg. N rate. The data further showed positive response to phosphorus but negative response to potassium. The yield of the 0-90-90 plot was lower by 17.4 cavans than that of the 0-90-0 plot and by 10.1 cavans than that of the 0-0-0 plot.

The negative response of Lipa loam in Maquiling to potassium can not be attributed to the amount of important exchangeable bases. The amount of each in this soil was comparable with those in the others which were not adversely affected by the addition of potassium (table 5).

The fertility of Lipa loam in the College of Agriculture was elevated significantly by nitrogen fertilization (table 1). The 45-kg. N application made an increase of 35.7 cavans over the control. The 90-kg. N rate gave a yield which was 10.1 cavans higher than that of 45 kg. N. There was no response to phosphorus and potassium.

The dry-season harvests, which were comparatively lower than those of the wet season from the same plots, showed results parallel to those of the wet season in relation to nitrogen. There was a response to phosphorus but none to potassium.

The response to phosphorus may be partly attributed to the heavy yield of corn in the previous harvest. The shelled corn alone was 69.6 cavans.

Response to fertilization in Batangas. Lipa loam in Sto. Tomas, when not fertilized with nitrogen, produced an average yield of 19.2 cavans of shelled corn, but when fertilized with nitrogen it

yielded an average of 35.0 to 51.2 cavans depending upon the amount of nitrogen (table 2). The increases in yield were proportional to the rates of nitrogen application. The 45-kg. N rate gave an increase of 15.8 cavans over the control, and the 90-kg. N rate, 16.2 cavans over the first 45 kg. N. From the trend of results, it may be deduced that the optimum nitrogen rate has not yet been reached. There was no response to phosphorus or potassium.

TABLE 2.—*Response of corn to fertilization in Batangas*

SOIL TYPE AND LOCATION	N TREATMENT	P-K TREATMENT -0-0	-90-0	-90-90	AVERAGE YIELD	RESPONSE TO
	kg./ha.	*yield in cavans per hectare (15% moisture)*				
Lipa loam	0	16.0	21.6	20.0	19.2	
Sto. Tomas	45	38.8	32.4	33.9	35.0	Nitrogen
CF-3 [a]	90	49.9	58.6	45.2	51.2	
		34.9	37.5	33.0		
SMD (N) 5%—6.72						

[a] Part of thesis of Raymundo Alvarez (1955).

It is recognized that phosphorus position in relation to the seeds is an important factor in phosphorus fertilization. In this connection, phosphorus placement test was conducted, the results of which are given in table 3.

TABLE 3.—*Effect of different levels of nitrogen and method of applying phosphorus on yield of corn in cavans (15% moisture)*

TREATMENT IN KG./HA.	LOCATION AND SOIL TYPE	
	Lipa loam, Maquiling, Calamba, Laguna CF-10	Ibaan loam, Pinagtungulan, Lipa City CF-12
0– 0–0	7.1	1.9
0–90–0	3.3	4.7
90– 0–0	22.8	30.5
90–90_p^a–90	22.7	32.8
90–90_t^b–90	23.0	37.9
135–45_p–90	34.7	41.1
135–90_p–90	32.9	41.9
135–90_t–90	36.8	43.3
135–135_p–90	36.5	41.5
135–135_p–0	36.9	45.3
SMD—5%	5.07	5.20

[a] Placed below seed.
[b] Placed same level as seed.

Lipa loam in Maquiling, Calamba, responded significantly to nitrogen. The yields increased with the rates of nitrogen application. For 90 kg. of N application, the increase was 15.9 cavans, and for 135 kg., 29.7 cavans.

When 90 kg. P_2O_5 was supplied with 90 kg. each of N and K_2O 5 cm. below the seeds, a yield of 22.7 cavans was obtained. The same rate of phosphorus applied at the same level as the seeds yielded as much as that placed below the seeds. With 135 kg. N, 45 kg., 90 kg., and 135 kg. P_2O_5 placed below the seeds gave corn yields statistically equal to each other and to that of 90 kg. P_2O_5 placed at the same level as the seeds.

The addition of potassium did not change the trend of results due to phosphorus.

The phosphorus placement test in Ibaan loam in Pinagtungulan, Batangas, showed results parallel to those in Lipa loam.

These findings on the failure of phosphorus in some locations to improve the yield of corn may be explained in terms of the presence of P_2O_5 in sufficient quantity in the soil rather than improper placement of fertilizer.

Response to fertilization in Rizal. The producing capacity of Guadalupe clay in Muntinlupa, Rizal, was significantly increased by the application of nitrogen with phosphorus (table 4). There was no response to potassium.

It is also evident that even if there was a response to nitrogen, no amount of the fertilizer could raise the yield of corn to the level of that obtained in Lipa loam, suggesting the presence of another critical element. The addition of 45, 90, and 135 kg. N per hectare gave only average yields of 0.06, 1.21, and 1.39 cavans, respectively. The control produced only 0.04 cavan.

When 90 kg. P_2O_5 was applied together with different rates of nitrogen, highly significant increases in yield were obtained. The increases over the corresponding controls were 20.54 cavans with 45 kg. N, 35.89 cavans with 90 kg. N, and 48.11 cavans with 135 kg. N. The results corroborate the fact that the beneficial effects of a fertilizing element deficient in soils can be fully realized only when all the other nutrients are present in adequate amounts.

When 90 kg. K_2O per hectare was added with varying rates of nitrogen and 90 kg. P_2O_5, the yields were similar to those of the cor-

TABLE 4.—*Response of corn to fertilization in Rizal* [a]

SOIL TYPE AND LOCATION	TREATMENT									
	0-0-0	45-0-0	90-0-0	135-0-0	45-90-0	90-90-0	135-90-0	45-90-90	90-90-90	135-90-90
	yield in cavans per hectare (15% moisture)									
Guadalupe clay, Muntinlupa, Rizal CF–8 SMD 5%—7.04; 1%—9.45	0.04	0.06	1.21	1.39	20.6	37.1	49.5	26.2	41.4	41.1

[a] Part of thesis of A. Anunciado (1955).

TABLE 5.—*Chemical properties of soils in three southern Luzon provinces*

SOIL TYPE AND LOCATION	pH	O. M.	P	C.E.C.	Ca	Mg	K	Na	Mn
		per cent	*ppm*			*m.e. per 100 grams soil*			
Laguna									
Lipa loam—Lalakay, Los Baños	5.95	1.20	75.88	23.77	11.97	3.98	1.13	—	Trace
Quingua fine sandy loam—Bañadero, Calamba	6.30	1.14	84.51	20.54	14.14	6.32	1.44	0.46	Trace
Lipa loam—Maquiling, Calamba	5.77	1.90	22.07	32.56	15.26	6.04	1.25	0.04	.01
Lipa loam—College	6.37	1.76	53.83	34.08	16.06	7.26	0.87	2.38	.07
Batangas									
Lipa loam—San Miguel, Sto. Tomas	5.40	1.59	63.44	20.78	10.60	5.88	0.89	0.19	Trace
Ibaan loam—Pinagtuñgulan, Lipa City	5.93	1.28	9.38	34.64	20.03	7.70	1.03	0.27	.02
Rizal									
Guadalupe clay—Muntinlupa	5.85	2.41	1.17	46.38	22.84	10.92	0.52	0.17	.05

responding N-P treatments, except that the yield of 135-90-90 was significantly lower than that of 135-90-0.

Chemical properties of soils and response to fertilization. In table 5, it may be seen that each soil had a pH value at which corn could produce average yields of 73 to 100 per cent of the highest yield (Thompson, 1952). Soil reaction, therefore, was not the critical factor in the test.

Since field tests have shown that all the soils responded to nitrogen, it may be advanced that the amount of 1.14 to 2.41 per cent organic matter was not a sufficient source of nitrogen for growing corn.

Lipa loam in Maquiling, Calamba, containing 22.07 ppm available phosphorus showed a response to phosphorus. Ibaan loam, in spite of its low phosphorus content of only 9.38 ppm, did not even suggest the need for phosphorus. Guadalupe clay, which contained only 1.17 ppm available phosphorus, showed a highly significant response to phosphorous. With regard to the response of Lipa loam in the College in the dry-season harvest, the amount of 53.83 ppm of available phosphorus found before the wet-season crop was harvested may suggest that it was not sufficient to last for several croppings.

Table 5 shows further that Quingua fine sandy loam containing 1.44 m.e. K per 100 grams soil needed potassium, as indicated by the yield of roasting corn ears. On the other hand, soils of heavier texture, loam and clay, having replaceable potassium as low as 0.87 and 0.52 m.e. K per 100 grams, respectively, did not show any indication of potassium deficiency. It may also be noted that the Lipa loam which was adversely affected by potassium contained only 0.04 m.e. sodium, which is much lower than the sodium contents of the other soils.

LITERATURE CITED

BARROS, FRANCISCO. 1940. A comparative study of the effects on the yield of corn of some leguminous crops used as green manure. Philippine Agriculturist 29: 142-149.

CALMA, V. C., AND D. L. CASTRO. 1950. The effect of the time of applying ammonium sulfate on the yield of corn. Philippine Agriculturist 34: 116-120.

CAMUS, JOSE S. 1914. Field tests of corn. Philippine Agriculturist and Forester 3: 193-204.

EUSEBIO, ROMUALDO V., AND DIOSCORO L. UMALI. 1952. A test of four green manure crops for corn. Philippine Agriculturist 36: 251-258.

MADRIGAL, JR., JOSE. 1941. Determination of fertilizer requirements of corn plants when grown in Lipa clay loam. Philippine Agriculturist 29: 877-891.

MONTELLANO, PEDRO L. 1916. A study of the effects of commercial fertilizers on corn. Philippine Agriculturist and Forester 4: 217-230.

THOMPSON, LOUIS M. 1952. Soils and fertility. 1st edition, xi + 339 p., 135 fig. New York and London: McGraw Hill Book Company.

PULSE RATE, FREQUENCY OF RESPIRATION, AND BODY TEMPERATURE OF HOLSTEIN-RED SINDHI CROSSBRED HEIFERS [1]

SANTIAGO P. TAN AND LEOPOLDO S. CASTILLO [2]

The highest pulse rate of Holstein-Red Sindhi crossbred heifers was in April, 76.4 a minute; the lowest was in November, 58.7 a minute. The mean was 68.2 a minute. The correlation coefficient of −0.624 between pulse rate and humidity was highly significant.

The highest monthly respiratory rate was in June, 38.1 a minute; the lowest was in December, 24.1 a minute. The mean was 30.2 a minute. There was a significant correlation coefficient of 0.697 between respiratory rate and atmospheric temperature.

The monthly body temperatures of the heifers varied significantly. The mean was 38.7°C. There were significant correlation coefficients of 0.608 between body temperature and atmospheric temperature and 0.503 between body temperature and humidity.

Since there are no data on the normal pulse rate, frequency of respiration, and body temperature of Holstein-Red Sindhi crossbred heifers, this study was conducted in the Department of Animal Husbandry from June, 1953, to May, 1954.

MATERIALS AND METHODS

Twelve healthy Holstein-Red Sindhi crossbred heifers were used in this study. At the start of the investigation, animals No. 12, 14, and 16 were one and a half years old; animals No. 17, 18, 19, 20, 21, 23, and 25 were one year old; and animals No. 24 and 26 were ten months old.

All the animals were given the same care and management. Concentrate feeds and ample water were given to them.

The pulse rate, respiratory rate, and body temperature were taken on the second and fourth weeks of every month between 8:00 and 12:00 in the morning in the milking barn. The pulse rate was taken on the outer surface of the mandible where the external maxillary artery is located. The average of three counts of 10 seconds

[1] Central Experiment Station Contribution No. 1855. This includes data from the thesis of the senior author presented for graduation with the degree of Bachelor of Science in Agriculture, October, 1954.

[2] The authors acknowledge the help extended by the Statistical Computing Service Section.

each, multiplied by six, was considered the pulse rate per minute. The nostrils were felt with the right hand for the respiratory movements. The average of three counts of one minute each was considered the respiratory rate per minute. In determining the body temperature, a veterinary clinical thermometer graduated in centigrade was fully inserted in the rectum and held there for at least two minutes.

The monthly data on relative humidity, atmospheric temperature, and rainfall were taken from the Weather Observation Division of the Department of Agricultural Engineering. Based on these data, the period from January to May was taken as the dry season, and that from June to December, the wet season.

RESULTS AND DISCUSSION

Pulse rate. The monthly variations in pulse rate of the 12 Holstein-Red Sindhi crossbred heifers were highly significant (table 1). Likewise, the pulse rates of the animals varied significantly. The highest average pulse rate was obtained in April, 76.4 a minute at an atmospheric temperature of 28.3°C., and the lowest was in November, 58.7 a minute at an atmospheric temperature of 25.0°C. The mean pulse rate was 68.2 a minute.

Villegas *et al.*[3] reported a slightly higher mean of 71.4 a minute for the dry Red Sindhi. Calo [4] noted that Holstein dams gave an average of 71.3 a minute, and the heifer calves, 81.6 a minute. Hermosura (1953) reported a higher pulse rate of 87 a minute at an atmospheric temperature of 83.4°F. (28.55°C.) for the dry Holsteins in Alabang Stock Farm, Rizal.

The correlation coefficients of −0.624 between pulse rate and humidity and −0.549 between pulse rate and rainfall were highly significant. These results indicate that the pulse rate of heifers decreases with an increase in humidity and rainfall. There was a significant correlation coefficient of 0.565 between pulse rate and atmospheric temperature.

In well-controlled experiments in psychrometric rooms, however, Regan and Richardson (1938) of California and Kibler and

[3] V. Villegas, F. S. Mensalvas, and L. S. Castillo, "A Comparative Study of the Pulse Rate, Frequency of Respiration, and Body Temperature of Holstein, Jersey, Brown Swiss, Red Sindhi, Sahiwal, Nellore, and Philippine Cows in the Shade and in the Sun." (Read at the 8th Pacific Science Congress, 1953).

[4] L. Calo, "A Study of the Pulse Rate, Frequency of Respiration, Body Temperature, Hemoglobin Index, and Blood Cell Counts of Holstein-Friesian Dams and their Daughters." (Thesis presented for graduation, 1954. Unpublished).

Brody (1950) of Missouri observed that pulse rate decreased as the temperature of the room was increased. The latter group of workers noted also that at 60°F. (15.55°C.) the Holstein had a rate of 63 a minute, whereas the Brahman had 66. At 99°F. (37.22°C.), the pulse rate of the Holstein dropped to 51 a minute, and that of the Brahman dropped to 59.

TABLE 1.—*Monthly and yearly means of pulse rates of Holstein-Red Sindhi crossbred heifers*

MONTH	PULSE	ANIMAL NUMBER	YEARLY PULSE
January	64.8	12	69.3
February	65.3	14	66.0
March	76.3	16	72.7
April	76.4	17	67.4
May	72.5	18	69.0
June	75.1	19	64.9
July	70.0	20	69.7
August	66.3	21	62.5
September	71.0	23	70.6
October	59.3	24	59.3
November	58.7	25	68.1
December	63.0	26	70.4
Mean	68.2	Mean	68.2

Analysis of variance

SV	DF	SS	MS	COMPUTED F	PROBABILITY
Month (M)	11	10,481.36	952.85	17.80 [a]	<.01
Animal (A)	11	2,012.03	182.91	3.42 [a]	<.01
Pooled error	265	14,182.39	53.52		
Total	287	26,675.78			

[a] Highly significant.
SMD (M): 5.88 at 5%
7.75 at 1%
SMD (A): 5.88 at 5%
7.75 at 1%

Respiratory rate. The means of the respiration rates of individual heifers, as well as the monthly means of all heifers, were highly significant (table 2). The yearly respiration rates among heifers varied from 25.4 to 33.9 a minute. The highest monthly respiration rate of 38.1 a minute at an atmospheric temperature of

28.5°C. was in June, and the lowest of 24.1 a minute at an atmospheric temperature of 25.8°C. was in December. The mean frequency of respiration was 30.2 a minute.

TABLE 2.—*Monthly and yearly means of respiration rates of Holstein-Red Sindhi crossbred heifers*

MONTH	RESPIRATION	ANIMAL NUMBER	RESPIRATION YEARLY
January	27.7	12	31.6
February	24.8	14	30.5
March	31.0	16	33.9
April	33.1	17	28.0
May	33.2	18	28.1
June	38.1	19	31.9
July	32.5	20	33.6
August	26.1	21	29.6
September	36.1	23	31.4
October	29.6	24	30.6
November	25.2	25	27.1
December	24.1	26	25.4
Mean	30.2	Mean	30.2

Analysis of variance

SV	DF	SS	MS	COMPUTED F	PROBABILITY
Month (M)	11	5,652.21	313.84	7.71 [a]	<.01
Animal (A)	11	1,784.41	162.22	3.96 [a]	<.01
Pooled error	265	10,777.92	40.67		
Total	287	18,214.54			

[a] Highly significant.
SMD (M): 5.12 at 5%
6.74 at 1%
SMD (A): 5.12 at 5%
6.74 at 1%

The trend of these findings is corroborated by Kibler and Brody (1950) who reported that at 60°F. (15.55°C.), the respiration of the Holstein was 29 a minute, whereas at 99°F. (37.22°C.), it was 114. At the same temperatures, the respiration rates of the Brahman were 18 and 96 a minute, respectively. A similar trend was observed by Regan and Richardson (1938) who reported a uniform increase in respiration rate which approximately doubled for each

increment of 18°F. (10°C.) from 40 to 100°F. (4.44 to 37.77°C.) using Jersey and Holstein cows.

Calo [5] obtained higher respiration rates than in the present study, with values of 50.8 a minute for the Holstein dams and 52.8 for the heifer calves. Villegas *et al.*[6] noted a lower respiration rate of 24.1 a minute for the dry Red Sindhi. In Louisiana, Johnston and Frye (1953) subjected Holstein and Red Sindhi-Holstein crossbreds to elevated temperatures and humidities in a psychrometric room. They reported that all crossbreds exhibited significantly lower body temperatures and respiratory rates than the Holsteins.

The correlation coefficient of 0.697 between respiratory rate and atmospheric temperature was highly significant. The correlation coefficient of −0.398 between respiratory rate and humidity was suggestive at 5 per cent probability level. The increasing percentage of humidity, in slowing up the respiration rate, may also decrease the rate of heat elimination from the body of the cow. Rainfall had no effect on respiration rate.

Body temperature. The monthly variations in temperature among the heifers were highly significant (table 3). The average monthly body temperature varied from 38.6 to 39.0°C. The heifers did not vary significantly from one another in body temperature. The mean was 38.7°C. These findings agree with those obtained in studies made in the College on Nellores, Holsteins, and Red Sindhis (Manresa and Falcon, 1939; Manresa and Erce, 1940; Villegas *et al.*[7]).

According to Seath and Miller (1946), the normal body temperature of Holstein cattle in Louisiana ranges from 101.2 to 106.5°F. (37.9 to 41.4°C.) with an average of 103.3°F. (39.6°C.). Again, Branton *et al.* (1953) of the same station reported that the body temperature of Holsteins averaged 104.2°F. (40.11°C.) with an environmental temperature ranging from 65 to 95°F. (18.33 to 35.0°C.) in April to September. Comparing Red Sindhi-Holstein crossbreds with Holstein heifers in a psychrometric room, Johnston and Frye (1953) stated that none of the crossbreds attained a temperature of 105°F. (40.55°C.); the Holsteins reached a body temperature of 107°F. (41.66°C.) and had to be removed from the chamber.

Kibler and Brody (1950) maintained that the critical temperature for Jerseys and Holsteins is 70 to 80°F. (21.11 to 26.66°C.);

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[5] Calo, *op. cit.*
[6] Villegas *et al.*, *op cit.*
[7] *Ibid.*

TABLE 3.—*Monthly and yearly means of body temperature of Holstein-Red Sindhi crossbred heifers*

MONTH	TEMPERATURE	ANIMAL NUMBER	TEMPERATURE YEARLY
	°C.		°C.
January	38.6	12	38.7
February	38.7	14	38.7
March	38.7	16	38.7
April	39.0	17	38.7
May	38.8	18	38.7
June	38.8	19	38.7
July	38.7	20	38.8
August	38.6	21	38.7
September	38.7	23	38.7
October	38.7	24	38.7
November	38.7	25	38.7
December	38.6	26	38.8
Mean	38.7	Mean	38.7

Analysis of variance

SV	DF	SS	MS	COMPUTED F	PROBABILITY
Month (M)	11	3.05	0.28	3.11 [a]	<.01
Animal (A)	11	0.64	0.06	0.67	>.05
Pooled error	265	22.63	0.09		
Total	287	25.92			

[a] Highly significant.
SMD (M): 0.25 at 5%
0.31 at 1%

that for Brahmans is 90 to 95°F. (32.22 to 35.0°C.). They explained the higher heat tolerance of the Brahmans as due to their greater surface area, which is about 12 per cent more than that of Jerseys of similar body weight. Lower milk production, feed consumption, and the inherently lower basal metabolism of the Brahmans were considered as other possible reasons.

In Beltsville, McDowell *et al.* (1953) subjected Jersey and Sindhis × Jersey (F_1) crossbred cows to a temperature of 105°F. (40.55°C.) with a vapor pressure of 34 mm. Hg. The Sindhi × Jersey crosses showed a smaller rise in rectal temperature (1.87 ± 0.152°F.) than did the Jerseys (3.06 ± 0.236°F.). The workers maintained that the superior heat tolerance of the crosses cannot

be attributed to a more sensitive respiratory response, but that the higher respiratory activities are compensatory responses displayed by individuals with lower heat tolerance.

The correlation coefficients of 0.608 between body temperature and atmospheric temperature and 0.503 between body temperature and humidity were significant at 1 per cent probability level. The findings indicate that the body temperature of the animals increased with atmospheric temperature and humidity.

The correlation between body temperature and atmospheric temperature is corroborated by Manresa *et al.* (1939) and Manresa and Falcon (1939) who worked on Nellore cattle. No correlation was found between the body temperature of heifers and rainfall. On the other hand, Calo [8] reported that the body temperature of Holstein dams is positively correlated with rainfall.

Effects of seasons. Seasonal variations affect the pulse rate, frequency of respiration, and body temperature of Holstein-Red Sindhi crossbred heifers. The pulse rate in the dry season (71.1 a minute) was higher than that in the wet season (66.2 a minute). Similarly, Villegas *et al.*[9] reported that during the dry season the pulse rate of Holsteins was 73.5, and in the wet season, 62.4 a minute.

The highest respiratory rate during the dry season was in May, 33.2 a minute, and the lowest was in February, 24.8 a minute. In the wet season, the highest was in June, 37.7 a minute, and the lowest was in December, 24.1 a minute. The means of respiration rate and body temperature in the dry season were 29.9 a minute and 38.8°C.; in the wet season, 30.3 a minute and 38.7°C.

Other observations. Three animals calved during the study: animal No. 12 on March 13, 1954; animal No. 16 on April 10, 1954; and animal No. 25 on May 5, 1954. Calving did not have any effect on pulse rate, frequency of respiration, and body temperature of the animals.

LITERATURE CITED

BRANTON, C., J. E. JOHNSTON, AND G. D. MILLER. 1953. Physiological and hereditary responses of lactating Holstein-Friesian and Jersey cows to natural environmental temperature and humidity. Jour. Dairy Sci. **36**: 585.

HERMOSURA, S. R. 1953. The performance of imported dairy cattle in the Philippines. Absts. of Papers Presented to the 8th Pacific Sci. Cong.: 279.

[8] Calo, *op. cit.*
[9] Villegas *et al.*, *op. cit.*

JOHNSTON, J. E., AND J. B. FRYE. 1953. Comparative heat tolerance of Holstein and crossbred Red Sindhi-Holstein heifers when exposed to elevated temperatures and humidities. Jour. Dairy Sci. 36: 585.

KIBLER, H. H., AND S. BRODY. 1950. Environmental physiology with special reference to domestic animals. XI. Effects of temperatures, 50 to 105°F. and 50 to 9°F., on heat production and cardiorespiratory activities of Brahman, Jersey, and Holstein cows. Mo. Agric. Exper. Sta. Res. Bull. 464.

MANRESA, M., F. GOMEZ, AND F. O. SANTOS. 1939. Hematological studies on cattle: II. Variations in hemoglobin in Indian Nellore oxen as affected by atmospheric temperature, relative humidity, body temperature, and certain chemical components of the blood. Philippine Agriculturist 28: 79-98.

MANRESA, M., AND P. R. FALCON. 1939. Hematological studies on cattle. III. Fluctuations in the hemoglobin of Indian Nellore oxen as affected by seasonal variation. Philippine Agriculturist 28: 187-205.

MANRESA, M., AND P. ERCE. 1940. Fluctuation of body temperature in the Jersey and Holstein-Friesian breeds of dairy cattle in the Philippines. Philippine Agriculturist 29: 452-458.

MCDOWELL, R. E., D. H. K. LEE, M. H. FOHRMAN, AND R. S. ANDERSON. 1953. Respiratory activity as an index of heat tolerance in Jersey (F_1) crossbred cows. Jour. Dairy Sci. 12: 573-581.

REGAN, W. M., AND G. A. RICHARDSON. 1938. Reactions of the dairy cow to changes in environmental temperature. Jour. Dairy Sci. 21: 73-79.

SEATH, D. M., AND G. D. MILLER. 1946. The relative importance of high temperature and humidity as factors influencing respiration rate, body temperature, pulse rate of dairy cows. Jour. Dairy Sci. 29: 465.

FOUR INSECTICIDE-FUNGICIDE COMBINATION SPRAYS IN THE CONTROL OF SOME INSECT PESTS AFFECTING CITRUS SEEDLINGS IN THE PHILIPPINES [1]

RODOLFO M. ELA

WITH THREE TEXT FIGURES

Bordeaux + DDT combination spray gave the best control of *Ferrisia virgata* Ckll. during the wet season, followed by C-O-C-S + DDT. Bordeaux + Toxaphene was ineffective against this insect in the dry season. The various treatments had no significant effect on *Aphis gossypii* Glover, *Phyllocnistis citrella* Stainton, and *Phaneroptera furcifera* Stal.

Seedlings sprayed with Bordeaux + DDT five times at two-week intervals made the best growth, followed by those sprayed with Bordeaux + Toxaphene ten times at weekly intervals. These seedlings had darker foliage and stems than the control or any of the other treated seedlings. Bordeaux + DDT and C-O-C-S + DDT produced poorer growth of seedlings when sprayed ten times at weekly intervals than when sprayed five times at two-week intervals.

Citrus seedlings are subject to the attack of a number of insect pests and diseases. Spraying them with insecticide-fungicide combination sprays, although not yet practiced to any extent in this country, may prove of value in the control of these pests and diseases. The present work was therefore conducted (1) to study the effect of four insecticide-fungicide combination sprays on the insect pests and diseases [2] affecting citrus seedlings, (2) to determine the burning effect of the combination sprays on the leaves and stems of the seedlings, and (3) to determine the effect of the treatments on the growth of the seedlings. The study was conducted in the Department of Agronomy experimental field from June, 1954, to January, 1955.

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[2] The effect of the treatments on diseases was studied by Mr. Rene P. Comagon under the direction of Visiting Professor Allan G. Newhall of the Department of Plant Pathology.

MATERIALS AND METHODS

Four insecticide-fungicide combination sprays were tested: (1) Bordeaux + DDT, (2) Bordeaux + Toxaphene, (3) C-O-C-S + DDT, and (4) C-O-C-S + Toxaphene. The insecticides used were Gesarol AK 50, a 50 per cent DDT wettable powder,[3] and Resitoxaphane 60, a 60 per cent emulsifiable toxaphene concentrate.[4] The fungicides used were C-O-C-S (copper oxychloride sulfate), containing 26.50 per cent active ingredient,[5] and Bordeaux mixture of the 3-3-50 formulation.[6] Gesarol was used at the rate of 15 grams to a gallon of water; Resitoxaphane, at the rate of 9.5 cc. to a gallon of water; C-O-C-S, at the rate of 13.6 grams to a gallon of water; and Bordeaux mixture, at the rate of 27.27 grams of copper and 27.27 grams of limestone to a gallon of water.

Two-month-old calamandarin seedlings (*Citrus mitis* Blanco × *Citrus reticulata* Blanco), about 20 centimeters tall, were sprayed with the different insecticide-fungicide combination sprays. The distance of planting was 30 × 30 centimeters and the distance between plots was 60 centimeters. Cultivation and weeding was done every two weeks until the end of the experiment. The experimental plots were divided into two randomized blocks, each block consisting of five plots or treatments. Border rows were not sprayed. Block I was sprayed five times at two-week intervals, and Block II was sprayed ten times at weekly intervals. Care was taken to protect the seedlings from the different sprays by using a canvas shield supported by two poles (fig. 1).

Before the first spraying, each plot was labeled with the treatment it was to receive. Tap water was used to dilute the sprays, and a two-gallon compressed-air sprayer was used for spraying. The relative abundance of the different insect pests was noted before the seedlings were sprayed. Observations were made on the effect of the insecticide-fungicide combination sprays on the leaves and stems of the citrus seedlings a week after the last spraying. Actual counts of the pest-infested plants were also performed a week after the last spraying. Growth was measured after a count of the affected plants. Two countings and two growth measurements were made, one during the wet season and one during the dry.

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[3] A Geigy Agricultural Chemicals product.
[4] A Shell Co. product.
[5] A Niagara Sprayer and Chemical Division product.
[6] Three pounds of copper and 3 pounds of limestone to 50 gallons of water.

DISCUSSION OF RESULTS

Insects that affected the seedlings. During the experiment the insects that attacked the citrus seedlings in the field were aphids (*Aphis gossypii* Glover),[7] mealybugs (*Ferrisia virgata* Ckll.),[8] leafminers (*Phyllocnistis citrella* Stainton), and katydids (*Phaneroptera furcifera* Stal.).

Fig. 1.—Canvas shield to protect the other seedlings from the spray. (*Photographed by the Photographic Division.*)

Citrus shoots infested by aphids and mealybugs are shown in figure 2.

Burning effect of treatments on leaves and stems of seedlings. There was no apparent burning effect on the plants sprayed with the materials. The seedlings sprayed with either Bordeaux + DDT or Bordeaux + Toxaphene exhibited much greener foliage and stems than the seedlings in the control and other treated plots. This is in accord with the supposition of De Ong (1948) that spraying with Bordeaux mixture increases the total amount of chlorophyll produced or slows down the removal of the products of assimilation. The same author stated that copper may be absorbed by the leaf from a copper sulfate solution.

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[7] Identified by Dean Leopoldo B. Uichanco.
[8] Identified by Dr. Silverio M. Cendaña of the Department of Entomology.

Fig. 2.—Left, citrus shoots infested by *Aphis gossypii* Glover; right, citrus seedlings infested by *Ferrisia virgata* Ckll. (*Photographed by the Photographic Division.*)

Effect on Phyllocnistis citrella. In analyzing the percentages of seedlings attacked by insect pests, the actual values were transformed into angles corresponding to percentages as given by C. I. Bliss (Snedecor, 1948).

There was no significant difference in leafminer infestation between the sprayed and control lots (tables 1a & b). The sprayed lots, however, tended to be less infested, especially those sprayed with Bordeaux + DDT.

TABLE 1a.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Phyllocnistis citrella (August to October, 1954)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	90.73	90.73	4.20
Treatment (T)	4	421.35	105.34	4.88 [a]
B × T	4	86.33	21.58	
Total	9	598.41		

[a] Nonsignificant.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	15.29	16.86	23.97	22.60	33.67
Percentage	7.0	8.4	16.5	14.8	30.7

TABLE 1b.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Phyllocnistis citrella (November, 1954, to January, 1955)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	34.07	34.07	5.99
Treatment (T)	3	104.88	34.96	6.14 [a]
B × T	3	17.07	5.69	
Total	7	156.02		

[a] Nonsignificant.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	0.00	8.99	7.39	11.04	19.95
Percentage	0.0	2.4	1.7	3.7	8.5

Effect on Aphis gossypii. In both the wet and dry seasons, no significant difference in aphid infestation was obtained between treatments (tables 2a & b). However, results obtained during the wet season were suggestive. There was a trend for the lots sprayed with Bordeaux + DDT or C-O-C-S + DDT to be more infested with aphids than the control. Isely (1950) found that calcium arsenate and DDT favor the development of aphids so that outbreaks may develop rapidly following the application of either of these insecticides. The treatments favor aphids by destroying their insect enemies.

TABLE 2a.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Aphis gossypii (August to October, 1954)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	14.47	14.47	1.04
Treatment (T)	4	344.31	86.08	6.17 [a]
B × T	4	55.84	13.96	
Total	9	414.62		

[a] Suggestive.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	20.53	5.92	15.41	5.92	7.78
Percentage	12.3	1.1	7.1	1.1	1.8

TABLE 2b.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Aphis gossypii (November, 1954, to January, 1955)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	55.36	55.36	1.17
Treatment (T)	4	342.20	85.55	1.81 [a]
B × T	4	189.24	47.31	
Total	9	586.80		

[a] Nonsignificant.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	29.34	12.53	19.06	14.48	17.28
Percentage	24.0	4.7	10.6	6.2	8.8

Effect on Ferrisia virgata. Except for Bordeaux + Toxaphene, the sprays significantly reduced the number of seedlings infested with mealybugs during the rainy season from August to October (tables 3a & b). Bordeaux + DDT gave the greatest reduction and C-O-C-S + DDT the next best, followed by C-O-C-S + Toxaphene. On the other hand, lots sprayed with Bordeaux + Toxaphene showed a significant increase over the control in number of seedlings affected by mealybugs in the dry season from November to January.

TABLE 3a.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Ferrisia virgata (August to October, 1954)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	.19	.19	.04
Treatment (T)	4	211.51	52.88	11.57 [a]
B × T	4	18.26	4.57	
Total	9	299.96		

[a] Significant at 5% level.
SMD (T) at 5% = 5.91.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	7.78	16.64	13.68	14.37	21.99
Percentage	1.8	8.2	5.6	6.2	14.0

TABLE 3b.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Ferrisia virgata (November, 1954, to January, 1955)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	19.26	19.26	2.18
Treatment (T)	4	407.67	101.92	11.56 [a]
B × T	4	35.26	8.82	
Total	9	462.19		

[a] Significant at 5% level.
SMD (T) at 5% = 8.22.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	7.78	25.50	11.02	20.58	15.39
Percentage	1.8	18.5	3.7	12.4	7.0

Spencer (1939) noted that heavy residues from sprays containing $Ca(OH)_2$ significantly increased scale insects in citrus trees and that the presence or absence of copper was unimportant. His experimental results suggest that a partial solution of the problem of scale build-up after Bordeaux mixture may be the reduction of residue-leaving hydrated lime in the spray to as low a quantity as horticultural or pathological considerations permit. Osburn and Spencer (1938) and Halloway and Young, Jr. (1943) made similar observations on the relation of inert residues and scales.

Griffiths and Thompson (1946), however, noted higher populations of citrus mealybugs on DDT-sprayed trees. According to them these increases appeared to result from the almost complete elimination of insects which are parasitic or predaceous upon mealybugs. The residual effect of toxaphene was not as prolonged as that of DDT, probably because its volatility is greater than that of DDT.

Effect on Phaneroptera furcifera. There was no significant difference in the percentages of plants damaged by katydids in the different treatments in the two trials (tables 4a & b).

Effect on growth of seedlings. In all the lots and in both the wet- and dry-season trials, the treated plants significantly grew faster than the control (tables 5a & b). The mean increases in height in centimeters of 45 seedlings from each of the different lots were 44.29 during the wet season and 53.21 during the dry for Bordeaux + DDT,

TABLE 4a.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Phaneroptera furcifera (August to October, 1954)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	2.45	2.45	.09
Treatment (T)	4	29.19	7.30	.27 [a]
B × T	4	105.62	26.41	
Total	9	137.26		

[a] Nonsignificant.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	25.75	30.65	26.23	27.73	27.68
Percentage	18.9	26.0	19.5	21.7	21.6

TABLE 4b.—*Analysis of variance of effect of treatments, based on the transformed angles of percentages of citrus seedlings attacked by Phaneroptera furcifera (November, 1954, to January, 1955)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block (B)	1	15.65	15.65	.61
Treatment (T)	4	398.30	99.58	3.88 [a]
B × T	4	102.63	25.66	
Total	9	516.58		

[a] Nonsignificant.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean angle	40.70	50.50	48.62	52.30	60.31
Percentage	42.5	59.5	56.3	62.6	75.5

42.92 and 53.10 for Bordeaux + Toxaphene, 38.00 and 48.91 for C-O-C-S + DDT, 38.95 and 46.99 for C-O-C-S + Toxaphene, and 31.59 and 37.96 for the control. The growth of the seedlings when sprayed with Bordeaux + DDT and C-O-C-S + DDT ten times at weekly intervals was poorer than when sprayed five times at two-week intervals, probably because of the increase in aphid infestation. Figure 3 shows the difference in growth between the control seedlings and the Bordeaux + DDT-treated seedlings at the close of the experiment.

TABLE 5a.—*Analysis of variance of effect of treatments on average growth in centimeters of citrus seedlings, based on 45 seedlings (August to October, 1954)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block	1	.0004	.0004	.0001
Treatment	4	198.35	49.59	11.98 [a]
B × T	4	16.55	4.14	
Total	9	214.90		

[a] Significant at 5% probability level.
SMD (T) at 5% = 5.64.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean	44.29	42.92	38.00	38.95	31.59

TABLE 5b.—*Analysis of variance of effect of treatments on average growth in centimeters of citrus seedlings, based on 45 seedlings (November, 1594, to January, 1955)*

SV	DF	SS	MS	COMPUTED F-VALUE
Block	1	.06	.06	.0095
Treatment	4	311.70	77.92	12.35 [a]
B × T	4	25.24	6.31	
Total	9	337.00		

[a] Significant at 5% probability level.
SMD (T) at 5% = 6.97.

Treatment	Bordeaux + DDT	Bordeaux + Toxaphene	C-O-C-S + DDT	C-O-C-S + Toxaphene	Control
Mean	53.21	53.10	48.91	46.99	37.96

Other observations. During the experiment, the seedlings suffered from scab, caused by *Elsinoe fawcetti* Bitancourt and Jenkins (*Sphaceloma fawcetti* Jenkins = imperfect stage), and citrus canker, caused by *Xanthomonas citri* (Hasse) Dowson (= *Phytomonas citri* Hasse).[9] Damage caused by these two diseases was light on seedlings treated with either Bordeaux + DDT or Bordeaux + Toxaphene, medium on those treated with either C-O-C-S + DDT or C-O-C-S + Toxaphene, and heavy on the control seedlings.

[9] Identified by Mrs. V. M. Ela of the Department of Plant Pathology.

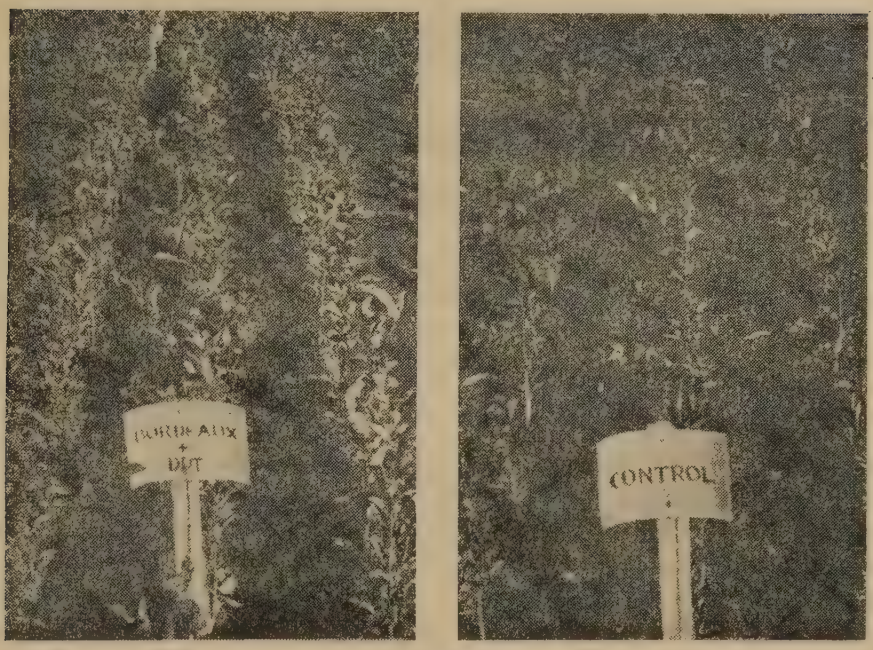

Fig. 3.—Difference between the growth of the Bordeaux + DDT-treated seedlings and of the control. (*Photographed by the Photographic Division.*)

The average rainfall during the wet-season spraying (August 6, 1954, to October 8, 1954) was 0.265 inch, whereas the average temperature was 80.35°F. In the dry-season spraying (November 5, 1954, to January 7, 1955), the average rainfall was 0.227 inch, whereas the average temperature was 77.57°F. as recorded by the Department of Agricultural Engineering.

LITERATURE CITED

De Ong, E. R. 1948. Chemistry and uses of insecticides. viii + 345 p. New York: Reinhold Publishing Corp.

Griffiths, J. T., Jr., and W. L. Thompson. 1947. The use of DDT on citrus trees in Florida. Jour. Econ. Entom. 40: 386-388.

Halloway, J. K., and T. R. Young, Jr. 1943. The influence of fungicidal sprays on entomogenous fungi and purple scale in Florida. Jour. Econ. Entom. 36: 453-457.

Isely, Dwight. 1950. Control of boll weevil and the cotton aphid in Arkansas. Univ. of Arkansas College of Agric. Exper. Sta. Bull. No. 496: 3-42.

Osburn, M. R., and H. Spencer. 1938. Effect of spray residues on scale insect population. Jour. Econ. Entom. 31: 731-732.

SNEDECOR, GEORGE W. 1948. Statistical methods applied to experiments in agriculture and biology. 4th ed., xvi + 485 p. Ames, Iowa: The Iowa State College Press.

SPENCER, HERBERT. 1939. Increases in citrus scale insect infestations from heavy residue and from copper spray mixtures. Jour. Econ. Entom. 32: 686-688.

FACTORS AFFECTING COSTS AND RETURNS OF PALAY PRODUCTION IN ILOILO [1]

EMILIO U. QUINTANA

Large size of farm was associated with large receipts per hectare on the irrigated farms. On the other hand, the average receipts per hectare on nonirrigated farms became consistently smaller as the size of farm increased. There was no direct relation between hectares in rice to expense per hectare on the irrigated farms, but on the nonirrigated farms, there was a tendency for expenses to become less with increased size of farm. High yields were associated with low cost per cavan. The smallest farms had the highest number of man and animal labor days per hectare for both irrigated and nonirrigated farms.

Costs and returns and profits or losses on farms are affected by a number of factors, some under the control of the individual operators. In Iloilo, from 1952 to 1953, the principal factors affecting the success of the rice farmers as shown by analysis of farm business records were (1) size of farm business, (2) rates of production, and (3) efficiency in the use of labor.

SIZE OF BUSINESS AND RECEIPTS

Large size of farm was associated with large receipts per hectare on the irrigated farms. The group with the smallest area per farm, less than 2.0 hectares, had average receipts of ₱114 (table 1). The average receipts per hectare of farms with 2 to 3 hectares to rice were 30 per cent higher than those of the smaller farms. As the size increased to 3.1 hectares or more, there was a further increase in receipts per hectare of almost 30 per cent. The average was ₱207.

TABLE 1.—*Size of business and receipts*

HECTARES PER FARM	RECEIPTS PER HECTARE	
	Irrigated	Nonirrigated
1.9 or less	₱114	₱595
2 to 3	164	213
3.1 or more	207	137

[1] Central Experiment Station Contribution No. 1857.

On the other hand, the nonirrigated farms had consistently smaller average receipts per hectare as the size of farm increased. The group of farms with 1.9 hectares or less had average receipts of ₱595 per hectare. When the hectares in rice were 2 to 3, the average receipts decreased more than 50 per cent. Such an inverse relation might be explained by the fact that on a farm with a smaller area for rice, the operator worked part of the time off the farm, which tended to increase receipts. As the area increased, the farmer no longer had time to devote to off-farms jobs but instead made inefficient use of his time on the farm.

SIZE OF BUSINESS AND EXPENSES

On the irrigated farms, there was no direct relation between hectares in rice to expense per hectare. The smallest group had an average expense of ₱136 per hectare (table 2). When the size was 2 to 3 hectares, the expense per hectare was about the same; when the size further increased to 3.1 hectares or more, the expense per hectare decreased somewhat.

TABLE 2.—*Size of business and expenses*

HECTARES PER FARM	EXPENSES PER HECTARE	
	Nonirrigated	Irrigated
1.3 or less	₱136	₱198
2 to 3	138	135
3.1 or more	128	105

Farm expenses per hectare tended to become less as the size of nonirrigated farms increased.

YIELD OF PALAY AND COST OF PRODUCTION

The yield of rice per hectare was an important factor affecting the cost of production. High yields were associated with low cost per cavan and low yields with high costs. When the yield of palay was 25 cavans or less, or an average of 21 cavans, the average cost per cavan was ₱17.88 for the irrigated and ₱12.84 for the nonirrigated farms (table 3). As the yield increased the cost per cavan consistently decreased. This was due to increased efficiency in the use of labor and capital and the spreading of fixed costs over a greater number of cavans.

TABLE 3.—*Relation of yield per hectare to cost per cavan*

CAVANS PER HECTARE	IRRIGATED		NONIRRIGATED	
	Av. cavan per ha.	Cost per cavan	Av. cavan per ha.	Cost per cavan
25 or less	21	₱17.88	21	₱12.84
26 to 35	33	14.06	30	10.70
36 or more	47	9.15	46	8.68

SIZE OF BUSINESS AND MAN LABOR

As a rule lower costs and greater efficiency are associated with larger size of farm. In this study the smallest farms had the highest number of man labor days per hectare for both irrigated and nonirrigated farms (table 4).

TABLE 4.—*Size of business and man labor days*

HECTARES PER FARM	MAN LABOR DAYS PER HECTARE [a]	
	Irrigated	Nonirrigated
1.9 or less	126	120
2 to 3	113	97
3.1 or more	93	74

[a] One work day = 8 hours.

The smaller amount of man labor required per hectare as farm size increased can be explained by the fact that there are operations which take just as long to perform on 1 hectare as on 3.

SIZE OF BUSINESS AND ANIMAL LABOR

The smaller the area in rice per farm, the more animal labor days were required per hectare (table 5).

TABLE 5.—*Size of business and animal labor days*

HECTARES OF RICE PER FARM	DAYS PER HECTARE [a]	
	Irrigated	Nonirrigated
1.9 or less	24	21
2 to 3	21	19
3.1	19	14

[a] One work day = 8 hours.

The apparent reason for the consistent decrease in animal labor per hectare as the size of farm increased was the more effective utilization of animal labor on larger farms. Much time is wasted in turning if the farm is small. There is not much difference in animal labor required to plow a seedbed for 1 hectare and a seedbed for 5 hectares. It takes about the same number of hours for an animal to pull a sled loaded with equipment to be used in preparing a 1-hectare as a 3-hectare rice field. It takes no longer to haul 3 cavans of seed to the same place as 1 cavan.

LAND REFORM BEHIND THE IRON CURTAIN [1]

Horst von Oppenfeld

Nearly half the world's population today lives in countries dominated by Soviet Russia. A drastic land reform is an essential element of the social revolution in these countries. Little information is available on the progress and welfare of rural people in Communist China or in the satellite countries of Eastern Europe. Occasional reports indicate that the Kolkhoz system is likely to be the final stage of a series of revolutionary developments.

The Kolkhoz, a synonym for the older Russian term, artel, has been defined as an "independent union of laborers working collectively and sharing the profits." Production is organized collectively, but consumption still takes place in family units.

The first step in the Russian land reform was the distribution of large estates among the small peasants and landless agricultural workers. Former owners received no compensation. The uneconomic fragmentation set the stage for subsequent reform. With minor variations this pattern is reported in all communist countries.

The origin of the Kolkhoz is described in the following terms. The manager of a Ukranian State Farm offered to lend a nearby village a tractor and mechanized equipment together with technical personnel. He stipulated "that all landmarks be removed and all the land thrown into one large piece, collectivized as it was called."

Russian leaders moved slowly during the first ten years of the revolution; only 19 per cent of the rural population was collectivized by 1927. But the Fifteenth Party Congress with its Five Year Plan threw full weight behind collectivization. The Model Statute for the Agricultural Artel was proclaimed by Joseph Stalin himself in a brochure entitled *Building Collective Farms:*

> "The agricultural workers, poor peasants and middle peasants of the village . . . voluntarily unite in an agricultural artel . . . to build up with common means of production and common organized labor, a large collective farm, and thereby to secure victory over the backwardness of small individual farms, and to guarantee a high productivity of labor and a large marketable output . . ."

[1] General Contribution No. 876. Paper read at symposium of the Farm Economics Association of the Philippines, October 5, 1955.

The Artel or Kolkhoz became nearly the sole form of Russian farm organization. To quote again the powerful Soviet leader:

> "Although the Commune is the higher form of the cooperative, conditions are not ripe for the Commune. The Kolkhoz will provide the foundation for the employment of machinery and tractors . . . and form a basis for transformation of the peasant and his psychology in the spirit of proletarian socialism."

Contributing factors to the swift realization of the new policy were the following conditions:

1. Hopelessly small peasant farms, the result of fragmentation of large estates, appeared to block the road to progress.
2. Transfer to the new type of ownership required no compensation as the land was now owned collectively by all the people.
3. Mechanized equipment was organized in the so-called MTS, i.e., Machine-Tractor-Stations, which served a number of collective farms.
4. Easy credit, allotment of supplies, taxation privileges, and the abolition of private property in land were all in favor of the Kolkhoz.

When the task was completed nearly all of the 25 million small farm units had been converted into 250,000 Kolkhoz units. Only one per cent of the farms remained in individual ownership while a few selected units were maintained under direct state control for the purpose of maintaining purebred herds or promoting seed propagation.

Membership in the Kolkhoz is open to wage earners and peasants, except kulaks and political undesirables, upon payment of an admission fee. Any land belonging to members becomes an indivisible part of the Kolkhoz. The homestead, about one-half hectare garden land, and a limited number of livestock may be retained by the individual members.

The Kolkhoz averages 75-100 families. In theory, the Kolkhoz is self-governing; the highest authority is the General Meeting of members. Actually, important decisions are made by the Management Committee which receives orders from government authorities. All work is done in groups called Brigades assigned by the Management Committee. No one may refuse to carry out his assignment. The Management Committee has disciplinary power ranging

from reprimand to expulsion and deportation. As one source puts it, expulsion sometimes reaches epidemic proportions.

State control over the Kolkhoz is maintained chiefly through the Machine-Tractor-Stations, the MTS. Owned and controlled by the State, they are more than machine lending centers. In addition to operators and mechanics, they employ agronomists and accountants who advise on farming practices and management.

Remuneration is determined by the number of labor days contributed. Skilled laborers are entitled to higher rates. When the harvest is divided, first claim is for state taxes and second claim for services received from tractor stations. Further deductions are made to pay for operating expenses such as seed, fertilizer, and animal feed. The balance, if any, is then distributed on the basis of labor days worked by the members.

One may wonder whether the objectives of the economic and social reorganization have been attained. The kulaks, a class of successful peasants, have been eliminated. Mechanization has released many farm laborers for industrial development, but output is still behind the expectation of the Soviet planners.

Professor Schiller who has a firsthand knowledge of Russian agriculture concludes:

> "Thus they created a cultivation system based on large-scale operation, with opportunity for extensive mechanization of the field work. This radical solution involved, however, such decisive disadvantages as (1) severe restriction of freedom of enterprise, (2) diminution of private interest and private initiative, and (3) red tape. Many people think that Russian agriculture is perhaps the weakest link in the chain that binds the political, social, and economic forces of Soviet Russia."

COLLEGE AND ALUMNI NOTES

"Agriculture and the Nation" was the motif of the 37th celebration of Loyalty Day this year at the College of Agriculture and Central Experiment Station.

Floats underlining the day's theme filed past an audience of 5,000 in the traditional civic and military parade from the campus gate to Baker Memorial Hall. Judged the best were the following entries: Department of Chemistry float—most colorful; Department of Agronomy float—most symbolic; Department of Engineering float—most effective; College of Forestry float—most original.

Guest speaker at the literary musical program at Baker Hall was Hon. Juan de G. Rodriguez, one of the original volunteers in the mass enlistment of 1918 and now secretary of the Department of Agriculture and Natural Resources. His speech was ushered in by musical selections by the Aggie Men's Glee Club and baritone Aurelio Estanislao.

Alumni and well-wishers of the College, among them Col. Harry Brenn, President Vidal A. Tan, Vice-President Enrique Virata, Gen. Alfredo Santos, and Governor Dominador E. Chipeco, were served luncheon at the Home Technology Building.

In the afternoon festivities were resumed with basketball games. The Los Baños faculty team won over the UP Faded Maroons and the Los Baños varsity lost to Mapua Tech.

The Student Body Organization dance at Baker Hall rounded up the day's activities.

Adding their fillip to the celebration were the Beta Sigma presentation of "H.M.S. Pinafore," under the musical direction of Mrs. Barbara York, and the art exhibit co-sponsored with the Women's Dormitory.

In the best Los Baños tradition, alumni all over the world reaffirmed their loyalty by letter, telegram, and cable. Messages were received from Feliciano L. Cruz, '41, Emilio T. Gamatero, '41, Felipe C. Galeon, '49, Ireneo B. Mendoza, '49, Carlos G. Benavidez, '51, at the Oklahoma A & M College;

Teodoro Cadiz, '52, Mariano Macanaed, '53, Evaristo Hurtado, '33, Melencio Rana, '37, Pedro Ventura, '35, Teodoro Olmo, '50, and Majindi Anuddin, '50, in Baton Rouge, Louisiana;

M. Salome del Rosario, '54, and Antonio L. Ordoveza, '55, at Kansas State College;

Nicomedes Flores, '27, Salvador Bolivar, '28, Salvador Pacion, '30, Guillermo Canlas, '33, Narciso Sibal, '34, Pio Tadina, '38, Santiago Rolle, '41, Telesforo Vea, '42, Elpidio Galado, '43, Romeo Espino, '37, at the University of Kentucky;

Avelino Bigornia, '49, Santiago Capco, '31, Ricardo M. Lantican, '54, Albino Varona, '29, in Raleigh, North Carolina;

Marcial Alviar, '49, and Irving P. Villasor, '53, in Valencia, Venezuela;

Mario O. San Juan, '50, Martin V. Jarmin, '40, Amado Campos, '49, Filomena Fortich Campos, Tomas Paterno, Orlando Sacay, '54, Agustin Pordesimo, '54, Concepcion L. Valera, '54, Igmidio Corpuz, '53, Lito Calo, '54, Genaro Ranit, '50, at Cornell University;

Vito F. del Fierro, '52, in Bangkhen, Bangkok, Thailand;

Ignacio Ang, '41, Emiliano Gianzon, '49, Eusebio Inocencio, '54, in Amparai, Ceylon;

Alumni in La Granja, La Carlota, and Victorias, Negros Occidental; Dumaguete City; Dansalan City; Echague, Isabela; Butuan City; Cebu City; Davao City; Iloilo City; and Del Monte, Bukidnon.

College scientists and men of industry met at the Plant Pathology Building on October 27 to confer on the problem of pest control.

Sponsored by the UP College of Agriculture and Central Experiment Station to bring research findings on insecticides, fungicides, and herbicides to the public, the Pest Control Conference started off with a welcome address by Dean Uichanco and ended with a panel discussion on research needs as seen by the commercial companies.

Representatives of participating firms listened to staff members of the Departments of Agricultural Botany, Entomology, and Plant Pathology discuss the following subjects:

Weed control in lowland rice—S. N. Fertig

Weed control in sugar cane—P. M. Zamora

Control of woody plants—G. C. Lugod

Experiments on control of pests of rice, corn, sugar cane, citrus, vegetables, bamboo—machinery for applying insecticides—G. B. Viado, S. M. Cendaña, J. G. Matthysse

Tobacco leaf spot control; coffee and citrus spraying experiments; seed and soil treatments—A. G. Newhall and F. T. Orillo.

In the afternoon Dr. M. G. Cline talked on the responsibilities of commercial companies to the farmers.

Top men of the Animal Husbandry Department represented the College at FAO meetings in Rome and India.

At the special request of the Director of the Agricultural Division of FAO, Dr. F. M. Fronda was appointed delegate to the Technical Meeting on Poultry Production in Asia and the Far East. The meeting was held in Poona, Bombay State, India, from October 17 to 27.

Dr. Fronda presented a paper to the body on improving poultry production through feeding.

Dr. Valente Villegas was designated member of the Philippine delegation to the Eighth Session of the FAO Conference in Rome, by virtue of his experience in animal husbandry and nutrition.

After attending the conference from November 4 to 25, Dr. Villegas plans to visit the artificial insemination centers at Cambridge University and Cornell University, the US Research Center at Beltsville, Maryland, the Swine Feeding Research Center at Iowa State College, and King Ranch, Texas.

Dr. Villegas will be away for four months.

Dr. Samuel C. Salmon joins the College as visiting professor of agronomy replacing Dr. J. L. Brewbaker.

As principal agronomist with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, USDA, Dr. Salmon was in charge of the wheat program for 20 years. He will help integrate the various phases of rice work in the Philippines.

Succeeding Dr. K. L. Turk is Dr. George W. Trimberger, visiting professor of animal husbandry.

As professor of animal husbandry in Cornell, Dr. Trimberger successfully coached the dairy cattle judging team from 1947. He has served as superintendent of cattle at the New York State Fair.

His extensive experience in artificial insemination is expected to help improve dairy operation in the Department of Animal Husbandry.

Dr. Valente Villegas read papers on "Comparative palatability of soilages" and "The capacity of Berkjala hogs for concentrate and

soilage" at the 236th meeting of the Los Baños Biological Club on September 30.

At the 237th meeting on October 21, Dr. K. L. Turk gave one of his last addresses winding up his one-year assignment to the College as visiting professor of animal husbandry. He spoke on the current researches in animal husbandry.

October's round of bienvenidas and despedidas included the Faculty and Employees' Club party on October 4 for Dean and Mrs. Leopoldo B. Uichanco, Dr. Francisco M. Fronda, Dr. and Mrs. Miguel Manresa, Jr., Mrs. Obdulia F. Sison, Dr. Gonzalo Garcia, and Messrs. Leopoldo Castillo, Jorge Davide, Martin Raymundo, and Basilio de los Reyes.

Another party on October 21 honored Dr. and Mrs. K. L. Turk, Dr. Valente Villegas, Dr. and Mrs. G. W. Trimberger, Dr. and Mrs. S. C. Salmon, and Mr. Boller.

Both affairs were held at the Seniors' Social Garden.

Eliseo N. Alcasid III, '54, holds the distinction of being the only poultry extension supervisor of F. E. Zuellig, Inc.

Jose L. Berenguer, '50, now manages the family farm in Arayat, Pampanga.

The College is appealing to its alumni for donation of the following issues of *The Philippine Agriculturist* to complete its collection in the College Library.

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	IX	(1921) nos. 6, 7.
	X	(1921-22) nos. 1, 5, 6, 7, 8, 9, 10.
	XI	(1922) nos. 1, 2.
	XII	(1923-24) nos. 1, 5, 9.
	XIII	(1924) no. 2.
	XVI	(1927) nos. 1, 5.
	XVII	(1928) nos. 1, 2, 3, 4, 5.
	XXVIII	(1939-40) nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Index.
	XXIX	(1940-41) nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Index.
	XXX	(1941) nos. 1, 2, 3, 4, 5, 6, 7, June-Dec.